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PARASITOLOGY

EDITED BY

GEORGE H. F. NUTTALL, F.R.S.

QUICK PROFESSOR OF BIOLOGY AND DIRECTOR OF THE MOLTENO INSTITUTE FOR RESEARCH IN PARASITOLOGY IN THE UNIVERSITY OF CAMBRIDGE

ASSISTED BY

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VOLUME XV MARCH, 1923 No. 1

REPORT ON A COLLECTION OF PARASITIC NEMATODES, MAINLY FROM EGYPT.

PART I. ASCARIDAE AND HETERAKIDAE.

BY H. A. BAYLIS, M.A., D.Sc.

(With 4 Text-figures.)

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WHEN Prof. E. Hindle took over the direction of the Biological Laboratory of the Egyptian Government School of Medicine, Cairo, he found there a large collection of parasitic worms, most of which had been accumulated by Prof. Looss while in charge of the Laboratory for a number of years prior to the Great War. As a large proportion of this material was unnamed, and as the named portion of it contained many specimens possibly of considerable value as original types or co-types, which had been in a neglected condition for some time, it was thought advisable to send duplicates of the collection to England, in order that part of it might be kept there in safer custody. It was also felt to be desirable that arrangements should be made for the examination and determination of the contents of the unnamed part of the collection.

Accordingly, Prof. Hindle communicated with Prof. G. H. F. Nuttall, F.R.S., with the result that duplicates of the collection were brought over to England, and presented by Prof. Hindle to the Molteno Institute for Research in Parasitology, Cambridge. Prof. Nuttall most kindly offered to present to the British Museum a first set of the material, and an arrangement was devised by him and the writer for ensuring the working-out of the undetermined portion of it by several workers. The named collection was at once entrusted to the writer's care, and duplicates will be deposited, as far as possible, in the British Museum (Natural History), the Molteno Institute, Cambridge, and the School of Medicine, Cairo.

The present paper is a first instalment of a report on the groups with which the writer has undertaken to deal. The report consists mainly of a list of determinations of the material which had not already been named by Prof. Looss, with the hosts from which it was collected; to which are added descriptions of a few new species and notes on some of the less well-known forms. For the sake of completeness, mention is also made of any material belonging to these groups which occurred in the previously-named collection. The number attached to each set of specimens is the serial number given to the original tube at the Molteno Institute.

Superfamily **ASCAROIDEA** Railliet and Henry, 1915.

Family ASCARIDAE Cobbold, 1864.

Subfamily ASCARINAE Travassos, 1913.

Genus **Belascaris** Leiper, 1907.

Belascaris marginata (Rud., 1802).

508. From dog. Locality, Cairo.

Genus **Toxascaris** Leiper, 1907.

Toxascaris leonina (v. Linst., 1902).

509, 520. From *Felis leo*. Loc., Zoological Gardens, Gizeh.

Toxascaris sp. indet.

510 (part). From Fennec fox.

The two specimens are in too macerated a condition for determination, the lips being much eroded.

Genus **Ophidascaris** Baylis, 1921.

Ophidascaris filaria (Duj., 1845).

515. From *Python molurus*.

Genus **Polydelphis** Duj., 1845.

Polydelphis quadricornis (Wedl, 1862), Baylis, 1921.

506. Stomach of *Naja haje*.

528. Stomach of "*Cerastes* ohne Hörner" (probably *Cerastes vipera*). Loc., Cairo.

Subfamily ANISAKINAE Raill. and Henry, 1912, *emend.* Baylis, 1920.

Genus **Porrocaecum** Raill. and Henry, 1912.

Porrocaecum angusticolle (Molin, 1860).

525. From *Buteo buteo* [*B. vulgaris*].
498. ,, *Archibuteo* [*Buteo*] *lagopus*.
511. ,, *Circus aeruginosus*.
492. ,, *Pernis* sp. (probably *P. apivorus*). Loc., Alexandria.

A new description of this species has been given by Baylis and Daubney[1], and it is there shown to belong to the genus *Porrocaecum*.

Porrocaecum reticulatum (v. Linst., 1899).

516. From *Ardea cinerea*. Loc., "Insel."

This species has also been redescribed and referred to this genus by Baylis and Daubney (*l.c.*).

[1] Report on the Parasitic Nematodes in the collection of the Zoological Survey of India. *Mem. Ind. Mus.* (*In Press.*)

Porrocaecum sulcatum (Rud., 1819).

Syn. *Ascaris sulcata* Rud., 1819.

514. Stomach of *Thalassochelys caretta* [*T. corticata*].

524. ,, ,, ,, ,,

533 (part). Stomach of *Thalassochelys caretta* [*T. corticata*].

502. Stomach of *T. caretta*.

497. ,, ,,

523. ,, ,,

Also, in the named collection, No. 100, determined by Looss as *Ascaris sulcata* R., from the stomach of *T. corticata* [*i.e.*, *T. caretta*]. Loc., Aboukir.

Ascaris sulcata has been briefly described by Schneider (1866, p. 43; Pl. I, fig. 11), and by Stossich (1895, p. 35; Pl. IV, figs. 8–11). The marked constriction behind the head, the elongated, hexagonal lips and the broad, flattened interlabia are very characteristic. The characters of the lips have been figured and described by both authors, and also the tail of the male, the number of postanal papillae being correctly given as six pairs. The most anterior of these, situated immediately behind the cloaca, is figured by both authors as a pair of simple papillae. In reality these papillae have double terminations. The remaining postanal papillae are somewhat variable in their arrangement, and the two sides are seldom symmetrical, so that Schneider's figure (*l.c.*, p. 43, text-fig.) is a more accurate representation than Stossich's evidently somewhat diagrammatic drawing. The spicules are slender and measure about 2·5 mm. in length. The ventral surface of the preanal region is longitudinally ribbed between the transverse striations.

The vulva is situated a little behind the anterior third of the total length. In a specimen 96 mm. long it was found to be at about 34 mm. from the anterior end. The vagina, at first a narrow muscular tube, runs posteriorly for about 3 mm., and then expands into a spindle-shaped reservoir (the unpaired portion of the uterus), full of eggs. This may be quite straight, or may be doubled upon itself. The tube then becomes narrower again, passing backwards and dividing into two wide uterine branches, which are rather short (about 17 mm.) and run quite straight backwards, parallel to each other. The oviducts turn anteriorly at their junction with the branches of the uterus, and the ovarian tubes run at first nearly straight forward, doubling back at about the level of the junction of the uterus and vagina, and occupying with their coils most of the space between the posterior end of the uterine branches and the caudal end of the body. The eggs measure about 0·1 × 0·055 – 0·062 mm., and have a somewhat lemon-shaped shell, rather pointed and thickened at the poles, and covered externally with granulations. Their contents are in early segmentation-stages at the time of laying.

This species must be assigned to the genus *Porrocaecum*, since it possesses a well-developed glandular ventriculus, oblong in shape, at the posterior end

of the oesophagus, and an intestinal caecum. The latter is very short, extending forward for only about one-third of the length of the ventriculus.

Dujardin (1845, p. 174) suggested the identity of *Ascaris sulcata* with *A. holoptera*, from land-tortoises. He had, however, not seen examples of the form from marine turtles, and the suggestion is without foundation, since in *A. holoptera* the oesophageal structure is entirely different, and has led the writer (1920) to erect for this species the genus *Angusticaecum*.

Porrocaecum decipiens (Krabbe, 1878) (?).

Larvae (= *Ascaris capsularia* Rud.).

526. Encapsuled in the mesentery of *Caranx trachurus*. Loc., Trieste.

Also, in the named collection (No. 27) some specimens determined by Looss as "*Ascaris capsularia* R. (larva)" from the abdomen of *Scrranus scriba*, from Trieste.

Porrocaecum sp. (?) (larval).

499. Encapsuled in *Anguilla anguilla* [*A. vulgaris*].

These specimens are now fragmentary, and it is difficult to make out whether they belong to a species of *Porrocaecum* or not; but a little diagram on the label in the tube appears to indicate the alimentary canal structure of a *Porrocaecum*, and probably means that this structure was observed in the fresh material.

Genus **Contracaecum** Railliet and Henry, 1912.

Contracaecum spiculigerum (Rud., 1809).

507, 534. Stomach of pelican.

Also No. 98 in the named collection, from *Pelecanus onocrotalus*. Loc., Alexandria.

The last-mentioned specimens are adults, determined by Looss as *Ascaris spiculigera*. No. 507 were also determined by him as young of the same species. These and No. 534 are all immature forms, but as far as their characters are recognisable they agree with *C. spiculigerum*.

Contracaecum aduncum (Rud., 1809).

505. From *Alosa finta*.

Contracaecum osculatum (Rud., 1802).

504 (part). From *Halichoerus grypus*.

Contracaecum fabri (Rud., 1819).

Syn. *Ascaris fabri* Rud., 1819.

Ascaris biuncinata Molin, 1858.

Some poorly-preserved specimens (No. 512) from *Zeus faber*, collected at Trieste, are referred to this species. Owing to the condition of the material, it is impossible to give a full account of it, although a new description is desirable. The fullest existing account appears to be that of v. Drasche (1883),

who describes the species under the name of *A. biuncinata*, and gives a figure of the dorsal lip.

The species has the characters of the genus *Contracaecum*, but is remarkable for the extreme shortness of the intestinal caecum, which scarcely reaches the anterior limit of the ventriculus. This great reduction of the caecum distinguishes this form from all other species of the genus hitherto met with in fishes. The oesophageal appendix is relatively long, measuring in the present material 1·1–1·7 mm.

The tail of the male is extremely short, and it is uncertain whether there are any postanal papillae. (Stossich (1896) states that there are 27 to 30 pairs of preanal and no postanal papillae.) The spicules are alate, and measure only 1–1·1 mm. in length.

The body of the gravid female is greatly swollen in the posterior half by the uterus, which has two voluminous branches running straight backwards. The eggs are subspherical, with a diameter of about 0·0625 mm.

Contracaecum cornutum (Stossich, 1904).

(Figs. 1 and 2.)

Syn. *Ascaris cornuta* Stossich, 1904.

A number of well-preserved specimens (No. 503) from *Thynnus vulgaris*, collected at Trieste, undoubtedly belong to this species. It is worthy of remark that the label in the bottle reads "Cori *leg.*, '03." This probably indicates that the material was sent to Prof. Looss by Prof. J. C. Cori, who also, in December, 1902, forwarded to Stossich the material upon which the latter's (1904) description was based.

It is possible to give a few more details than are furnished by Stossich in his rather brief description, which was unaccompanied by figures. The males in the present material are smaller than Stossich's, the largest measuring 23 mm. in length (Stossich gives 32 mm.). The largest female is about 49 mm. long. The greatest thickness is 0·53 mm. in the male, 1·25 mm. in the female. The cuticular striations, which have rather prominent edges, like minute sawteeth, are at intervals of about 7·5 μ in the male and 10 μ in the female. The diameter of the head is about 0·16–0·2 mm. The general characters of the lips have been indicated by Stossich. The shape of the pulp of the dorsal lip, the position of the papillae and the shape of the interlabia are characteristic, and will be best understood from the accompanying figure (Fig. 1).

The distance from the anterior extremity to the posterior end of the oesophagus (including the small ventriculus) is 3–4 mm. The ventriculus is subglobular and measures 0·13–0·15 mm. in length. The slender oesophageal appendix is 1·2–1·65 mm. long, while the intestinal caecum is very short, extending only to a distance of 0·2–0·23 mm. in front of the ventriculus. The nerve-ring is situated at about 0·4 mm. from the anterior end in the male, 0·54 mm. in the female. The very inconspicuous cervical papillae and the excretory pore are at about the same level, just behind the nerve-ring.

The tail of the male measures about 0·15 mm. in length. It diminishes rapidly in diameter from the cloaca, and ends in a much narrower, tapering appendage, 0·04–0·06 mm. long. Stossich states that caudal papillae are

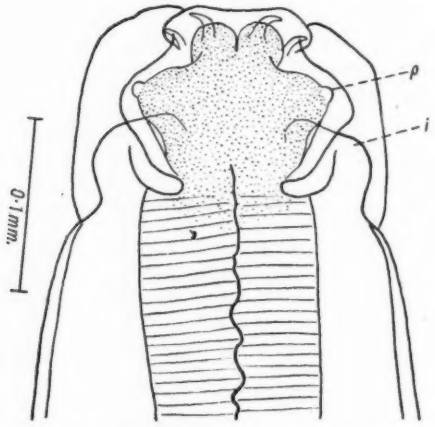

Fig. 1. *Contracaecum cornutum.* Head of female; dorsal view. *i.* interlabium; *p.* papilla.

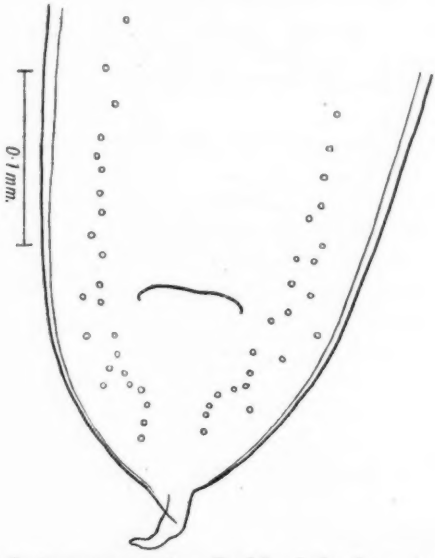

Fig. 2. *Contracaecum cornutum.* Caudal end of male; ventral view.

absent, but adds a query in parenthesis. Actually the papillae are numerous, though for the most part very minute. There appear to be ten or eleven pairs of very small postanal papillae, arranged as indicated in Fig. 2. The preanal

series begins with about 14 pairs of similar small papillae. The more posterior of these are arranged in an irregular double row on either side, beginning at the level of the cloacal aperture. More anteriorly the row becomes single. Further forward still, and in continuation of the single row, is a series of about 18 papillae on either side, of much larger size than those already mentioned. There are therefore, in all, at least 42 pairs of papillae. The alate spicules are subequal, measuring about 1·9 mm. in length.

The tail of the female is, for an Ascarid, of an unusual shape, as has been described by Stossich. It measures about 0·94 mm. in length, and tapers gradually from the anus to a conical point. The vulva is within the anterior fifth of the body (in a specimen 34·6 mm. long it is situated at 6·6 mm. from the anterior end). The vagina is stout and muscular, and runs straight back for a distance of over 2·5 mm. The coils of the genital tubes extend backward to within about 4 mm. of the anus, and forward as far as the posterior end of the vagina, the terminations of the ovaries being posterior. The ova in the uterus are thin-shelled and of irregular shapes, their average diameter being about 0·075 mm. Their contents are at the morula stage when ready for laying.

Contracaecum filiforme (Stossich, 1904).

Syn. *Ascaris filiformis* Stossich, 1904.

Some small, very slender forms (No. 500) from the gall-bladder of *Uranoscopus scaber* at Trieste, immature but with lips already formed and genital organs developing, are referred to this species, which is clearly a *Contracaecum*. It is impossible to add anything to Stossich's (1904) description, owing to the lack of any distinctive characters in the lips of these specimens, and to their general immaturity.

It may be mentioned here that *Ascaris rigida* Rud., 1809, must be added to the species of *Contracaecum* inhabiting fishes. It is possibly identical with *Ascaris marina* L., or with *A. lophii* Müll., but is distinct from *Contracaecum aduncum* (Rud.), although some authors have included it in the synonymy of that species. From its description, *Ascaris plagiostomorum* v. Linst., 1905, seems also to be a *Contracaecum*. Of forms from hosts other than fishes, *Ascaris aquillae* Smith, Fox and White, 1908, from *Haliaëtus*, should also be referred to this genus.

Contracaecum sp. indet. (*a*).

A single female (No. 529) from the stomach of *Coris julis*. Loc., Alexandria. The head is so much damaged that determination is impossible.

Contracaecum sp. indet. (*b*).

A single male (No. 531 (part)), in poor condition, from *Lucioperca sandra*. Loc., Leipzig.

Contracaecum sp.

535. A number of immature forms from the stomach of *Ardea cinerea*. Loc., Damietta.

The specimens are of various sizes, and possibly not all of the same species.

Contracaecum sp.

517. Larval forms from *Mugil capito*.

Genus **Paranisakis**, nov.

Paranisakis squatinae, sp. n. (Figs. 3 and 4.)

Some well-preserved specimens (No. 521) of an Ascarid from *Squatina squatina* [*S. angelus*] are of considerable interest. The male measures up to 80 mm. in length, the female up to 115 mm. The maximum thickness is about 0·9 mm. in the male and 1 mm. in the female. The cuticular striations are at intervals of 12·5 μ in both sexes. The diameter of the head is 0·2–0·27 mm. The characteristic shape of the dorsal lip and of its pulp will be best understood from the figure (Fig. 3). Small interlabia are present. Dentigerous ridges appear to be absent.

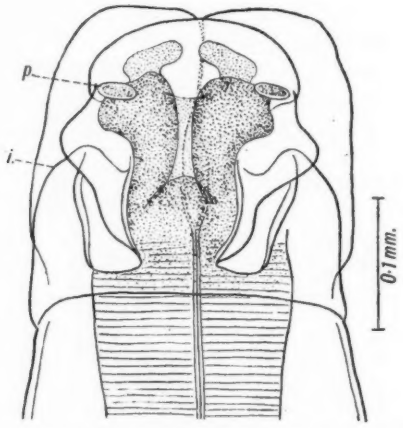

Fig. 3. *Paranisakis squatinae.* Head of female; dorsal view. *i.* interlabium; *p.* papilla.

The distance from the anterior extremity to the posterior end of the oesophagus, including an oval ventriculus, varies from about 4 to 6 mm. The ventriculus measures 0·35–0·37 mm. in length and 0·24–0·3 mm. in transverse diameter. Neither an oesophageal appendix nor an intestinal caecum is present. In both sexes the cervical papillae are situated at about 1 mm., the nerve-ring at 0·85 mm., and the excretory pore at 0·65 mm., from the anterior end.

In the male, the tail is 0·25–0·28 mm. in length. There are two alate, subequal spicules, the left measuring 1·15 mm. and the right 1·07 mm. They have rather a rough, irregular appearance, as if not perfectly chitinised. In addition to the spicules, there is a massive accessory piece, measuring 0·4 mm. in length and exhibiting a laminated structure. There are six pairs of postanal papillae (Fig. 4), of which one is sublateral, the rest more ventral. Twelve pairs of preanal

papillae have been counted. They are placed at very long intervals from each other. The ventral surface of the preanal region is longitudinally ribbed between the transverse striations.

In the female, the tail is conical, and tapers rather rapidly. It measures 0·6–0·7 mm. in length. The vulva is situated at about 40 mm. from the anterior end in a specimen 115 mm. long. The vagina is stout and muscular, and runs back for about 7 mm. before opening into the unpaired portion of the uterus. This runs back for about another 12 mm. before branching. The two branches run back for about 20 mm. The coils of the ovarian tubes extend forward to a point from 1 to 5 mm. in front of the vulva, and backward to within about 7 mm. of the posterior end. In the females there is a characteristic double

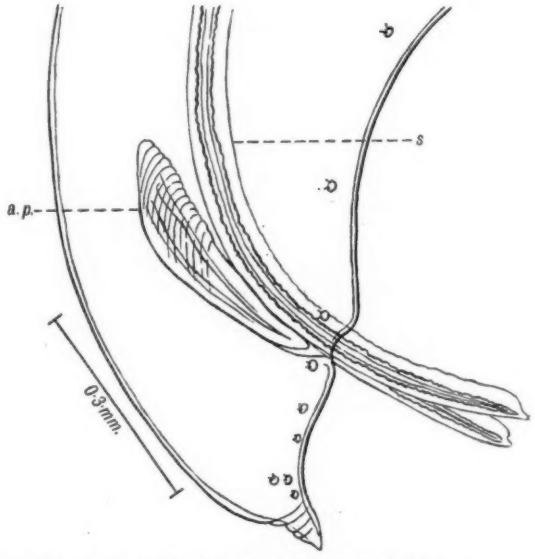

Fig. 4. *Paranisakis squatinae.* Caudal end of male; lateral view. *a.p.* accessory piece; *s.* right spicule.

bend or kink in the intestine in the neighbourhood of the vulva—sometimes in front of it and sometimes behind it. The eggs are lenticular in shape, and have a thin shell, finely granulated externally and measuring 0·0825 × 0·0675 × 0·04 mm. The content of the egg is undifferentiated and granular, and separated by a considerable space from the shell, at the time of laying.

It is not without hesitation that a new genus has been erected for the reception of this species; but a review of the combinations of characters exhibited in the subfamily Anisakinae shows that it does not fit into any of the genera hitherto proposed. It resembles *Anisakis* in having a ventriculus but no intestinal caecum or oesophageal appendix; but differs from it in the possession of interlabia and in the absence of dentigerous ridges on the lips. As regards

the characters of the head it approaches very closely to *Contracaecum*, and in fact the whole organisation of the worm suggests a *Contracaecum* in which the characteristic intestinal and oesophageal appendages have been lost.

Note on *Anisakis* Duj., 1845.

It is convenient here to mention that, according to the writer's observations, *Ascaris diomedeae* v. Linst., 1888, is an *Anisakis*. In his description of this form, in the "Challenger" *Report*, v. Linstow states that there are both intestinal and oesophageal caeca, but on a re-examination of the type-material it appears that he must have mistaken the excretory gland for these structures. It is interesting to find a representative of this genus occurring in a bird, all the other known species occurring in mammals.

Ascaris patagonica v. Linst., 1880, also belongs to this genus, and is perhaps a synonym of *Anisakis similis* (Baird, 1853).

Larval Ascaridae.

A number of immature Ascarids, encapsuled in the body-cavity of reptiles, occur in the collection. It seems possible that they all belong to the same species, but at present it is impossible to determine forms of this type from reptiles, and we know nothing of their life-history. The lips are not yet developed in these specimens. Some individuals have a short intestinal caecum, but there is no ventriculus, so that they cannot belong to the subfamily Anisakinae, the members of which, so far as is known, normally have an encapsuled larval stage. They must, apparently, belong to the Ascarinae.

The hosts in the present collection are the following:

518. *Naja haje*. Loc., Cairo.
522. *Naja haje*.
532. "Snake." Loc., Cairo.
530. *Agama stellio* [*Stellio vulgaris*]. Loc., Alexandria.

Family HETERAKIDAE Railliet and Henry, 1914.

Subfamily Heterakinae Railliet and Henry, 1912.

Genus **Heterakis** Duj., 1845.

Heterakis monticelliana Stossich, 1892.

Syn. *Heterakis stylosa* v. Linst., 1907.

Of this species the collection contains one male and eleven females (No. 573) from *Otis tarda*, the type host. The locality is given as Leipzig. The single male has unfortunately been slightly damaged by the loss of the extreme posterior end, carrying the characteristic caudal appendage mentioned and figured by both describers.

There seems to be very little doubt that *H. stylosa* is a synonym of *H. monticelliana*, although the description of the latter given by Stossich (1892) is very incomplete. The lateral view of the caudal end of the male given

by this author (Pl. II, fig. 9) shows admirably the highly characteristic shape of the sucker. The apparent difference in the outline of the male tail in ventral view, as given by the two authors, is probably to be explained by different degrees of tilting, Stossich's figure being somewhat foreshortened. Some of the caudal papillae were evidently not seen by Stossich, but their number and arrangement in the present male specimen agree, as far as can be made out, with the description and figure given by v. Linstow (1907, p. 253, and Pl. VI, fig. 6). Both authors mention the presence of papilliform cuticular bosses in the vulvar region of the female, and these are also invariably present to the number of three or four in the present specimens. It seems highly probable, as has been suggested by Baylis and Daubney (*l.c.*) in the case of *Heterakis isolonche*, that these bosses are produced by the action of the sucker of the male. Contrary to the statement of Stossich, narrow lateral alae are present throughout almost the whole length of the body.

Heterakis tenuicauda v. Linst., 1883.

491. "*Perdix gris.* var." [Perhaps *Perdix griseogularis* Brandt, now known as *Ammoperdix griseogularis*.] "Fedsch. 1870. Mus. Lips."

There seems to be some slight possibility that these specimens may be part of the original material from which the species was described. v. Linstow (1883) described the species among worms collected by Fedchenko in Turkestan, and sent to him by Leuckart. The host is given by him as *Perdix graeca* (this is *Caccabis chukar*, and is not the same bird as *Ammoperdix griseogularis*), and his specimens, or at least the females, seem to have been considerably smaller than these.

Genus **Ascaridia** Duj., 1845.

Ascaridia perspicillum (Rud., 1803).

490. From common fowl. Loc., "Holzbg."

485 (part). From common fowl. [Loc., Cairo?]

Ascaridia columbae (Gmel., 1790).

The named collection contains (No. 97) "*Ascaris maculosa* R." from *Columbia livia*.

Ascaridia hermaphrodita (Fröl., 1789).

Syn. *Fusaria truncata* Zed., 1803.

496. From *Pionus* [*Psittacus*] *menstruus*. Loc., Leipzig (presumably in captivity—the bird is the South American red-vented parrot, and is not uncommon as a cage-bird).

Genus **Strongyluris** Müller, 1894.

Strongyluris brevicaudata Müller, 1894 (?).

460. From *Agama stellio* [*Stellio vulgaris*]. Loc., Alexandria. (Females only.)

A tube in the named collection (No. 122), labelled "*Heterakis cincta* v. L.—Host *Stellio vulgaris*. Loc., Alexandria. XII. 97. Ident. Looss," contained

two females, not yet fully mature, of a species of *Strongyluris*, probably *S. brevicaudata*. This species, of course, has nothing to do with *Oxyuris cincta* v. Linst., 1897, and it seems not improbable that the tube originally contained other material besides these two specimens, since *Oxyuris cincta*, from the same host, is also represented in the collection.

Genus **Spinicauda** Travassos, 1920.

Spinicauda sonsinoi (v. Linst., 1894).

435 (part). From *Chalcides* [*Gongylus*] *ocellatus*.

452. From rectum of *Chalcides* [*Gongylus*] *ocellatus*. Locality, Alexandria.

Spinicauda icosiensis (Seurat, 1917).

451 (part). From rectum of *Chalcides* [*Gongylus*] [*ocellatus*?]

The name *Sonsinia* was proposed by Baylis and Daubney (*l.c.*) for the two species just mentioned and *S. campanula* (v. Linst., 1899). Although a paper by Travassos, mentioning the genus *Spinicauda*, was referred to, his definition[1] of *Spinicauda* had not been seen at the time, and the contents of his genus were unknown. It appears that the species of *Spinicauda* are the same as those of *Sonsinia* (*S. campanula* being regarded as a synonym of *S. spinicauda* (Olfers, 1819)), with the doubtful addition of *Heterakis flexuosa* Schneider, 1866. The name *Sonsinia* must therefore lapse.

Subfamily Subulurinae Travassos, 1914.

Genus **Subulura** Molin, 1860.

Subulura suctoria Molin, 1860.

Syn. *Allodapa suctoria* (Mol.) of Seurat.

? *Heterakis rima* v. Linst., 1906.

This species occurs in the collection from a variety of hosts. In the named collection one tube (No. 123) contains specimens determined by Looss as *Heterakis suctoria*, from *Athene noctua*; locality, Matarieh, Cairo. Material from the following hosts in the unnamed collection is also assigned to the species:

485. Common fowl. [Locality, Cairo?]

487. Turkey (caeca). Loc., "Insel."

493. *Athene noctua* (caeca). Loc., Matarieh, Cairo. (Probably part of the same batch of material as No. 123, already mentioned.)

486. *Athene noctua* (caeca). Loc., Rosetta.

488. "*Otis houbara*" (*Houbara macqueeni* or *H. undulata*) (caeca). Loc., Heluan.

437. *Caprimulgus europaeus* (caeca). Loc., Cairo.

494. *Caprimulgus europaeus* (caeca).

The specimens from "*Otis houbara*" do not agree with the description of *Subulura forcipata* (Rud.) of Seurat, 1914. It seems not improbable that *Heterakis rima* v. Linst., 1906, is a synonym of *S. suctoria*. v. Linstow's specimens were small, and do not seem to have been mature[2].

[1] *Mem. Inst. Oswaldo Cruz*, xii. 1 (1920), p. 45. [2] *Cf.* Seurat's (1914, *a*) remarks under *S. forcipata*.

The material from *Athene* cannot be assigned to *Allodapa noctuae* Seurat, 1914. The spicules agree with those of *S. suctoria* from other hosts, and are not short and without alae, as described by Seurat (1914, *b*) for *noctuae*.

The genital papillae of the males from *Caprimulgus europaeus* agree with those of *S. suctoria*, and not with those of *S. leprincei* (Gendre, 1909), recorded from the same host.

The species *suctoria* is referred by Seurat to the genus *Allodapa* Dies., 1861, which he regards as distinct from *Subulura*.

Family KATHLANIDAE Travassos, 1918.

Genus **Kathlania** Lane, 1914.

Kathlania leptura (Rud., 1819) Travassos, 1918.

Syn. *Kathlania kathlena* Lane, 1914.

401. From *Thalassochelys caretta* [*corticata*]. (Determined by Looss as "*Oxys. leptur.*" (*sc. Oxysoma lepturum*).)

402. From rectum of *Thalassochelys caretta*.

439. From *Thalassochelys caretta* [*corticata*].

Also in the named collection, No. 117, "*Oxyuris lepturum* R., from *Thalassochelys corticata* (i.e., *caretta*), Aboukir. Ident. Looss."

Travassos (1918) has expressed the view that *Kathlania kathlena* Lane, 1914, is a synonym of *K. leptura*. The material mentioned above has been compared with the type-specimens of *K. kathlena*, which are in the British Museum, and this comparison confirms the opinion of Travassos.

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REPORT ON A COLLECTION OF PARASITIC NEMATODES, MAINLY FROM EGYPT.

PART II. OXYURIDAE.

By H. A. BAYLIS, M.A., D.Sc.

(With 3 Text-figures.)

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The following is a continuation of the foregoing Report (*Parasitology*, xv, pp. 1–13). As in the first part, the numbers are those given to the original tubes at Cambridge.

Family OXYURIDAE Cobbold, 1864.

Genus **Oxyuris** Rud., 1803, *sens. strict.*

Oxyuris equi (Schrank, 1788).

Tube No. 465 contains a number of male specimens of this species, from the caecum and colon of *Equus asinus*; locality, Cairo. These had been determined by Looss as *O. curvula* Rud.

Genus **Oxyuris**, *sens. lat.*

Oxyuris albanica Stossich, 1898.

Syn. *O. inflata* v. Drasche, 1884, *nec* v. Linstow, 1883.

453. From *Testudo* sp.

455 (part). From *Testudo leithii* [*T. kleinmanni*].

Oxyuris dentata v. Drasche, 1884.

433 (part). From *Testudo graeca.*

455 (part). From *Testudo leithii* [*T. kleinmanni*].

Oxyuris loveridgei Baylis, 1920.

447 (part). From *Macroscincus coctaei.* Locality, Ilho Branco, Cape Verde Is.

The label also reads "Parona *ded.*" The tube contained a mixture of this species and *Tachygonetria* [*Paracis, Oxyuris*] *paronai* (*q.v., infra*), and is in all probability part of the type material of *O. paronai* v. Linstow, 1893[1].

[1] See Baylis, 1920, *Ann. and Mag. Nat. Hist.* (9), vi, p. 123.

Oxyuris robusta v. Drasche, 1884.

455 (part). From *Testudo leithii* [*T. kleinmanni*].

433 (part). From *Testudo graeca*.

This species has been renamed *O. draschei* by Stossich, but as the name *robusta* has not been used for any other *Oxyuris*, the reason for this is not apparent.

Oxyuris diesingi Hammerschmidt, 1838.

438 (part). From the rectum of *Periplaneta* [*Blatta*] sp.

Oxyuris blattae-orientalis Hammerschmidt, 1847.

438 (part). From the rectum of *Periplaneta* [*Blatta*] sp.

Oxyuris blatticola Galeb, 1878 (?).

438 (part). From the rectum of *Periplaneta* [*Blatta*] sp.

The foregoing three species have all been fully described and well figured by Galeb (1878).

Genus **Syphacia** Seurat, 1916.

Syphacia obvelata (Rud., 1802).

463. From *Microtus* [*Mus*] *arvalis*. Locality, Leipzig.

469. From the caecum of *Gerbillus aegyptius*.

Genus **Enterobius** Leach, in Baird, 1853.

Enterobius vermicularis (L., 1758).

Syn. *Fusarella vermicularis* (L.) of Seurat, 1916.

The named collection contains (No. 70) some specimens labelled *Oxyuris vermicularis*, from the rectum of *Homo sapiens*; locality, Cairo.

Enterobius bipapillatus (Gedoelst, 1916).

Syn. *Oxyuris bipapillata* Gedoelst, 1916.

440. From the rectum of *Semnopithecus entellus*; Zoological Gardens, Gizeh.

These specimens are referred to Gedoelst's species in spite of some slight discrepancies in measurements, etc. The males have an extra pair of caudal papillae, in a lateral position, at the level of the two small ventral pairs shown by Gedoelst. The spicule of the male measures only about 0·06 mm. in length, instead of 0·08 mm. The number and arrangement of the papillae correspond exactly with Seurat's (1916) figure of "*Fusarella*" *vermicularis*, and the species is undoubtedly to be referred to *Enterobius*. The chief point of difference between the two species is the length and shape of the spicule.

It should perhaps be mentioned that the host, in the present case, is an Indian monkey, while the host of Gedoelst's type-material was an unnamed monkey from the Belgian Congo.

Genus **Aplecta** Railliet and Henry, 1916.

Aplecta acuminata (Schrank, 1788).

Syn. *Nematoxys commutatus* auctt.

430 (part), 537. From *Rana temporaria*. Locality, Leipzig.

442, 472. From *Rana mascariensis*. [Egypt.]

436, 466. From *Bufo regularis*. Locality, Alexandria.

456. From "toad." [Cairo.]

Railliet and Henry (1916) have endeavoured to clear up the confusion that has long existed with regard to the nomenclature of this and the next species, but the writer feels that the determination of these forms still rests on an insecure foundation, owing to the unsatisfactory character of the existing descriptions. No attempt, however, is made here to give new descriptions, owing to the scarcity of males, the fact that little of the present material is from European hosts, and the poor or immature condition of much of it.

Genus **Cosmocerca** Dies., 1861.

Cosmocerca ornata (Duj., 1845) Raill. and Henry, 1916, *nec* Dies., 1861.

430 (part). From *Rana temporaria*. Locality, Leipzig.

428. From rectum of frog. [Egypt.]

Genus **Tachygonetria** Wedl, 1862.

Syn. *Paracis* Raill. and Henry, 1916.

Tachygonetria vivipara Wedl, 1862.

445, 462 (part). From the rectum of *Uromastix spinipes*.

[449 (part). From *Testudo kleinmanni*, according to the label. The host is almost certainly wrongly given, especially as the material also includes *Thelandros alatus* (*vide infra*), a form usually occurring in *Uromastix* and not in tortoises.]

Tachygonetria longicollis (Schneider, 1866).

Syn. *Paracis longicollis* (Schneider) of Raill. and Henry, 1916.

433 (part), 450. From the rectum of *Testudo graeca*.

455 (part). From the rectum of *Testudo leithii* [*T. kleinmanni*].

This species was indicated by Railliet and Henry as the type of the genus *Paracis*. On a comparison of this species, and also of *T. paronai* and *T. microstoma* (*vide infra*), with *T. vivipara*, the type of *Tachygonetria*, there seems to be no doubt that the two genera are one and the same, and *Tachygonetria* therefore takes precedence.

An excellent diagnosis of the genus *Tachygonetria* is given by Seurat (1917). The species may be either viviparous or oviparous, and sometimes, as in the genotype, both oviparous and viviparous females occur together in the same species.

Tachygonetria microstoma (v. Drasche, 1884).

Syn. *Oxyuris microstoma* v. Drasche, 1884.

443. From *Testudo* sp. (Determined by Looss as *Oxyuris longicollis*.)

v. Drasche, the describer of this species, saw only males. The present material contains many females, which probably belong to the same species as the males, though they differ from them somewhat in appearance. The species has probably been confused by some authors with *Oxyuris longicollis* Schneider.

The females measure 6–8 mm. in length, and up to 0·3 mm. in thickness. The body is long and slender in build compared with that of the female of *P. longicollis*. The tail is 0·55–0·7 mm. long, and tapers gradually to a sharp point. The oesophagus (including the bulb) is 1·6–1·8 mm. long (in the male, only 0·7–0·8 mm.). The excretory pore is situated at about 0·25–0·3 mm. behind the bulb. The vulva opens at 3·5–3·7 mm. from the posterior end. The muscular vagina runs forward along the ventral side for about 0·5–0·7 mm., and then turns back for a short distance before giving off the uterine branches. The eggs measure about 0·175–0·19 × 0·1 mm.

Tachygonetria paronai (v. Linst., 1893).

Syn. *Paracis paronai* (v. Linst.) of Baylis, 1920.

447 (part). From the rectum of *Macroscincus coctaei*. Locality, Ilho Branco, Cape Verde Is. (From the collection of Parona.)

These specimens are probably part of the type-material of the species—see note under *Oxyuris loveridgei, supra*.

Genus **Pharyngodon** Dies., 1861.

Pharyngodon auziensis Seurat, 1917.

448. From the rectum of *Scincus* sp. [probably *S. officinalis*].

528 (part). From the rectum of "*Cerastes* ohne Hörner" [probably *Cerastes vipera*]. Locality, Cairo.

The latter is probably a case of a "pseudoparasite." The material consists of a single female, in poor condition.

Pharyngodon mamillatus (v. Linst., 1897).

(Fig. 1.)

461. From the rectum of *Eumeces* sp.?

As Seurat (1917) has pointed out, the figure and description of the head of this species given by v. Linstow (1897) are misleading. They evidently refer to a specimen with the head retracted, and the cuticle of the neck invaginated so as to give the appearance of a buccal cavity. There is, in reality, no buccal cavity, and the mouth appears to be surrounded by six very insignificant lips.

v. Linstow's figure of the tail of the male is also rather too schematic, and it seems desirable to give a new figure. The peculiar lateral inflations of the cuticle just anterior to the commencement of the caudal alae are wrongly

shown as solid by v. Linstow. The outer adanal (or anterior postanal) pair of papillae have their pulps greatly expanded at the base, and these expan-

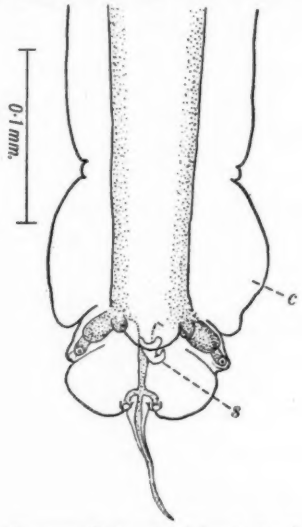

Fig. 1. *Pharyngodon mamillatus.* Caudal end of male; ventral view.
c., cuticular inflation; *s.*, spicule.

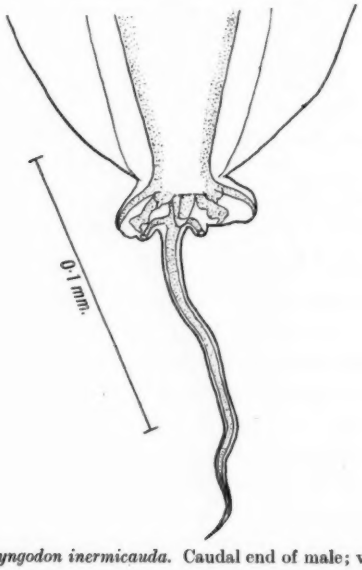

Fig. 2. *Pharyngodon inermicauda.* Caudal end of male; ventral view.

sions bulge ventrally. The actual papilla is situated at the end of a narrower distal portion of the pulp.

Pharyngodon inermicauda, sp. n.

(Fig. 2.)

468, 454. From *Tarentola annularis*. Locality, Cairo.

434. From ? *Tarentola annularis* or *Ptyodactylus lobatus*.

This species approaches most closely to *P. spinicauda* (Duj., 1845), as redescribed by Seurat (1914, 1917), but differs from it in that (1) the caudal filament of the female is devoid of spines, and (2) the lateral alae of the male are very much broader than in *P. spinicauda* (see Seurat's (1914) figures of that species).

The male measures 1·72–1·8 mm. in length, and in maximum thickness (without the alae) 0·11–0·14 mm. Measured in the dorso-ventral position, the greatest total width, including the alae, is 0·23–0·3 mm. The cuticular striations are about 4 μ apart. The lateral alae originate at 0·13–0·23 mm. from the anterior end, rapidly becoming wider on passing backwards, and diminishing again rapidly in width posteriorly, to end just in front of the cloaca. At this point the caudal alae begin, and these expand rapidly into a somewhat bell-shaped bursa-like structure, supported on the dorsal side by the tail, which is produced into a tapering filament about 0·12–0·16 mm. in length.

The diameter of the head is 0·018–0·022 mm. The oesophagus, including the posterior bulb, is 0·27–0·32 mm. long. The subspherical bulb measures 0·057–0·067 mm. in length and 0·05–0·057 mm. in transverse diameter. The nerve-ring is situated at 0·063–0·1 mm., and the excretory pore at 0·45 mm., from the anterior end.

As usual in the genus, three pairs of caudal papillae are present. Those of the preanal pair are sessile and have nipple-like terminations, directed posteriorly. The two postanal pairs have long peduncles, those of the anterior pair being of irregular outline, while those of the posterior pair are slender and bent at an obtuse angle, their terminations being situated at the posterior edge of the alae. No definite spicule could be made out, but whether it is absent or merely imperfectly chitinised it is impossible to say. In this respect the species resembles *P. megalocerca*, according to Skrjabin's (1916) description.

The mature female measures 4·05–4·725 mm. in length and 0·31–0·38 mm. in thickness. The cuticular striations are about 12·5 μ apart. The diameter of the head is about 0·05 mm. The total length of the tail, which diminishes suddenly after the anterior 0·15–0·2 mm. to a slender, tapering filament, is 0·9–1·0 mm. The oesophagus, including the bulb, is 0·44–0·48 mm. long. The bulb measures 0·11–0·12 mm. in length and 0·11–0·13 mm. in width. The nerve-ring is situated at 0·14–0·16 mm., the excretory pore at 0·8–0·87 mm., and the vulva at 0·95–1·03 mm., from the anterior end. The vagina runs posteriorly from the opening. The ova are spindle-shaped, with a button-like knob at each pole. They measure 0·15–0·17 mm. × 0·057–0·07 mm.

Seurat (1917) has given a key to the four species of *Pharyngodon* found by him to occur in North Africa. The genus, however, includes at least two other

previously-known species, and to these must now be added *P. inermicauda*. An attempt is here made to include all these seven species in a more comprehensive key.

KEY TO SPECIES OF *PHARYNGODON*.

A. Caudal alae of male include posterior pair of postanal papillae.

a. Anterior pair of postanal papillae forked. *P. auziensis* Seurat, 1917.

b. Anterior pair of postanal papillae not forked.

a. Cuticle of male, between posterior end of lateral alae and beginning of caudal alae, inflated on either side. *P. mamillatus* (v. Linst., 1897).

b. Cuticle of male not inflated at junction of lateral and caudal alae.

α. Tail of female spiny. . . . . *P. spinicauda* (Duj., 1845).

β. Tail of female without spines. . . *P. inermicauda*, sp. n.

B. Caudal alae of male do not include posterior pair of postanal papillae.

a. Tail of female spiny. . . . . *P. extenuatus* (Rud., 1819).

b. Tail of female without spines.

a. Lateral alae of male confined to posterior region of body. *P. laevicauda* (Seurat, 1914).

b. Lateral alae of male begin near the anterior end. *P. megalocerca* (Skrjabin, 1916).

Genus **Thelandros** Wedl, 1862.

Thelandros alatus Wedl, 1862.

458. From the large intestine of *Uromastix spinipes*.

462 (part). From *Uromastix spinipes*.

[449 (part). From the rectum of *Testudo kleinmanni*, according to the label. The host is evidently wrongly stated. The material consisted of a mixture of *T. alatus* and *Tachygonetria vivipara* (*vide supra*), both of which normally occur in *Uromastix* and not in tortoises.]

The named collection also contains (No. 99) a tube labelled "*Oxyuris uromasticola* Galeb," from *Uromastix spinipes*. As Seurat has shown, *O. uromasticola* is a synonym of *Thelandros alatus*.

Thelandros bulbosus (v. Linst., 1899) Seurat, 1917, typical form.

435 (part). From *Chalcides* [*Gongylus*] *ocellatus*; (apparently three sets of specimens mixed).

451 (part). From the rectum of *Chalcides* [*Gongylus*].

Thelandros bulbosus, var. *annulatus* (v. Linst., 1899) Seurat, 1917.

435 (part). From *Chalcides* [*Gongylus*] *ocellatus*.

451 (part). From the rectum of *Chalcides* [*Gongylus*].

Thelandros micipsae Seurat, 1917.

451 (part). From the rectum of *Chalcides* [*Gongylus*].

427. From the rectum of *Scincus officinalis*. Locality, Cairo.

464. From the rectum of *Seps chalcides* [probably *Chalcides tridactylus*].

429. From the rectum of *Cerastes cornutus*. Locality, Cairo. [? pseudo-parasite.]

Thelandros cinctus (v. Linst., 1897).

(Fig. 3.)

Syn. *Oxyuris cincta* v. Linstow, 1897.

459. From the rectum of *Agama stellio* [*Stellio vulgaris*]. Locality, Aboukir.

457. From the rectum of *Agama stellio* [*Stellio vulgaris*]. Locality, Cairo.

431. From the rectum of ? *Agama* sp.

Of this species unfortunately only a single male is available, but this specimen has some very striking characters, and, since v. Linstow only described the female, it seems desirable to give some account of it.

It measures 3·1 mm. in length and (excluding the lateral alae) 0·4 mm. in thickness. The greatest width between the edges of the broad alae is 0·56 mm. The alae originate at a point about 0·62 mm. from the anterior end, and are narrow at first, but gradually become wider posteriorly, their widest part being quite near the posterior end of the body. They end at some little distance in front of the cloaca, leaving the caudal extremity free. Their edges, however, are produced posteriorly into prominent angles which give the worm an appearance quite different from that of any other species. The cuticle is very coarsely striated, the striations being most conspicuous anteriorly to the origin of the lateral alae, and again towards the posterior end of the body. In the former region they are up to 30 μ apart, and in the latter up to 38 μ.

The diameter of the head, or rather that of the neck at the point where the head is invaginated into it, is 0·06 mm. The oesophagus, including the bulb, is 0·78 mm. long. The bulb measures 0·14 mm. in length and the same in transverse diameter. The nerve-ring is situated at 0·19 mm., and the excretory pore at 1·1 mm., from the anterior end.

The caudal extremity is provided with the usual three pairs of papillae, one preanal and two postanal. The anterior postanal papillae are very prominent and laterally placed. The posterior pair of postanal papillae is situated on the terminal appendage of the tail, at about one-third of its length from the base. This appendage is probably normally curved towards the ventral side, as in other species of the genus, but has become straightened out in this specimen (as shown in Fig. 3 *B*) as the result of manipulation. It measures 0·112 mm. in length. The anterior lip of the cloacal aperture is apparently simple and without denticulations. Its posterior lip forms a rather long, posteriorly-directed, conical process, with rounded extremity. The spicule (the extreme tip of which is missing) probably measures about 0·067 mm. in length.

Mature females measure 5·9–7·0 mm. in length and 0·6–0·83 mm. in thickness. The diameter at the point of invagination of the head is 0·08–0·09 mm. The total length of the oesophagus is 1·07–1·43 mm. The bulb measures 0·18–0·2 mm. in length and 0·22–0·25 mm. in width. The nerve-ring is situated at about 0·2 mm., and the excretory pore at 1·55–1·8 mm., from the anterior end. The tail is about 0·2 mm. long, including the blunt, rounded, postanal portion of the body and a terminal spike which measures 0·1–0·12 mm. The vulva, in the form of a conspicuous transverse slit, is situated slightly behind

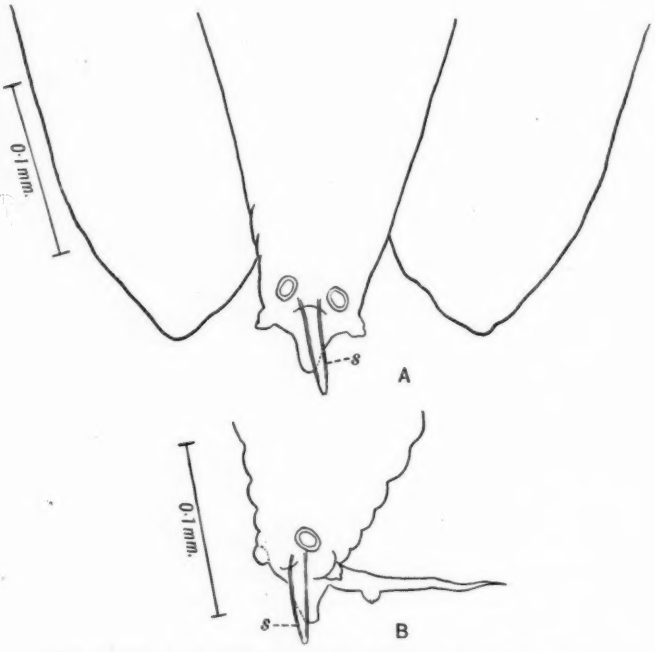

Fig. 3. *Thelandros cinctus.* Caudal end of male; *A.*, ventral view; *B.*, lateral view; *s.*, spicule.

the middle of the body, at 3·1–3·65 mm. from the anterior end. The eggs are of roundish-oval shape and measure about 0·113–0·138 × 0·063–0·075 mm.

Of the species already assigned to *Thelandros*[1], this form approaches in many respects most closely to *T. micipsae* Seurat, 1917. The characters of the lateral alae and of the caudal region in the males, however, are entirely different. Apart from measurements (in which there are some important differences), the females are readily distinguished by the following criterion:

[1] A useful key to North African species is given by Seurat (1917), p. 413. His suggestion (footnote, same page) that *Oxyuris paronai* v. Linst., 1893, belongs to this genus, is erroneous (*vide supra, Tachygonetria paronai*).

in *T. cinctus* the coils of the genital tubes are confined to the postoesophageal region, while in *T. micipsae* the ovarian tubes invariably form a conspicuous coil lying across the oesophagus in front of the bulb.

Genus **Isakis** Lespès, 1856 (?).

Isakis gryllotalpae (Dufour, 1837) (?).

467. From the intestine of larva of *Gryllotalpa*.

The material consists of very small specimens, in bad condition and probably immature. They may belong to this species, but no satisfactory description of it has been found in literature. v. Linstow (*Compendium der Helminthologie*, Nachtrag, 1889, p. 106) mentions an account of it by Dadai, with a plate, but this has unfortunately not been accessible.

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REPORT ON A COLLECTION OF PARASITIC NEMATODES, MAINLY FROM EGYPT.

PART III. CAMALLANIDAE, Etc.

WITH A NOTE ON *PROBSTMAYRIA* AND AN APPENDIX ON ACANTHOCEPHALA.

By H. A. BAYLIS, M.A., D.Sc.

(With 8 Text-figures.)

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As in Parts I and II of this Report (*Parasitology*, xv, pp. 1–23) the numbers are those given to the original tubes at Cambridge.

Superfamily **SPIRUROIDEA** Railliet and Henry, 1915.

Family CAMALLANIDAE Railliet and Henry, 1915.

Genus **Camallanus** Railliet and Henry, 1915.

Camallanus lacustris (Zoega, 1776).

Syn. *Cucullanus elegans* auctt.

531. From the intestine and pyloric appendices of *Lucioperca sandra*. Locality, Leipzig.

Camallanus cyathopharynx, sp. n.

(Figs. 1 and 2.)

411 (part). From *Heterobranchus anguillaris*. Locality, Cairo.

The chief peculiarity of this species is the presence of a large chitinous "buccal cavity" or "pharynx" behind and in addition to the usual paired buccal valves. This structure (Figs. 1, 2, *ph.*) is in all probability a development of the chitinous ring which usually separates the valves from the oesophagus, and which Dujardin termed the pharynx. The usual "tridents" are present, and the buccal valves are provided with about 10–12 longitudinal ribs of irregular lengths.

The largest male measures 5·9 mm. in length, and the largest female 9·2 mm. The maximum thicknesses for the two sexes are 0·12 mm. and 0·18 mm. respectively. The cuticular striations are about 6μ apart. The length of the chitinous buccal apparatus, including the paired "valves" and the "pharynx,"

is 0·1–0·13 mm. The oesophagus, measured from the extremity of the head and including both muscular and glandular portions, is 0·93–1·1 mm. long in the male, 1·28–1·32 mm. in the female. The muscular portion alone, measured from the extremity of the head, is 0·44–0·56 mm. long in the male and 0·65–0·67 mm. in the female. The nerve-ring is situated at 0·13–0·15 mm. from the anterior end in the male, 0·17–0·18 mm. in the female. The very minute cervical papillae are immediately behind the nerve-ring, and the excretory pore slightly in front of the posterior end of the muscular portion of the oesophagus.

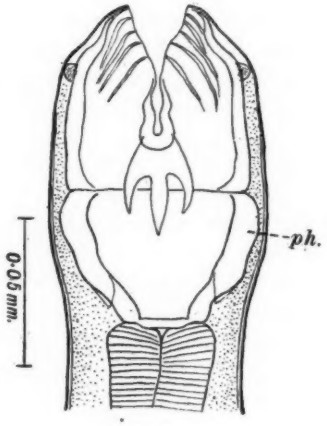

Fig. 1

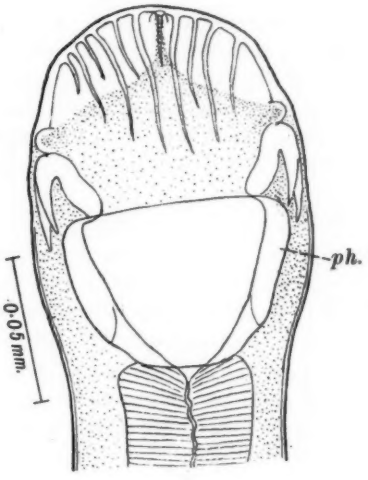

Fig. 2

Fig. 1. *Camallanus cyathopharynx.* Head of female; dorsal view. *ph.*, pharynx.
Fig. 2. *Camallanus cyathopharynx.* Head of female; lateral view. *ph.*, pharynx.

The length of the tail in the male is 0·05–0·07 mm. The characters of the caudal end could not be satisfactorily made out, and possibly none of the male specimens were quite mature. No spicules could be detected. The only papillae that could be certainly identified were five pairs of preanal papillae, placed at rather long intervals along the sides of the body, which in this region is thickened and expanded in the manner usual in the genus.

The tail of the female is 0·35–0·4 mm. long. The vulva, the lips of which are not prominent, is situated slightly behind the middle of the body (at 4·3 mm. from the posterior end in a specimen 9·2 mm. long). The vagina runs posteriorly for 0·8 mm. before entering the uterus. The general characters of the female organs are those typical for *Camallanus*, and the worm is, as usual, viviparous.

Genus **Procamallanus,** *nov.*

Procamallanus laeviconchus (Wedl, 1862).

Syn. *Cucullanus laeviconchus* Wedl, 1862.
Camallanus laeviconchus Raill. and Henry, 1915.

This species was originally recorded by Wedl (1862) from *Synodontis schaal*, a Silurid freshwater fish from Egypt. The present collection contains specimens (No. 480) from another Silurid fish, *Bagrus bayad*, which, in spite of the much larger size of the mature females, apparently belong to the same species.

Wedl describes the mouth as being provided with the two shell-like chitinous valves characteristic of "*Cucullanus*" (*i.e. Camallanus*). Actually, however, the chitinous lining of the buccal cavity seems to be uninterrupted, and not divided into two lateral portions. It thus forms a "buccal capsule" closely simulating that of many Strongylidae. Wedl's figure of the head (1862, Pl. I, fig. 1) is quite in accordance with the appearance of the present material. The rib-like longitudinal thickenings of the chitin usual in *Camallanus* are absent.

The armature of the mouth thus differs in a striking manner from that characteristic of *Camallanus*. Further, the "tridents" of *Camallanus* are absent, and there are no other structures in their place. This is not unnatural, since it is to the tridents in *Camallanus* that the muscles are attached which control the movements of the chitinous valves, and therefore in the absence of the valves the tridents would be unnecessary.

On the ground of these differences it seems necessary to make this species the type of a new genus, which may perhaps be regarded as a near approach to the primitive form from which *Camallanus*, with its complex mouth-parts, has probably been derived.

The males in the present material measure up to 3·65 mm. in length and 0·11 mm. in thickness; the females up to 15·5 mm. and 0·35 mm. respectively. (Wedl describes the females as 6–7 mm. long.) The cuticle is rather coarsely striated, the interval between the striations reaching as much as 20 μ. The diameter of the head, at the widest part of the buccal capsule, is 0·06–0·08 mm. The buccal cavity measures 0·0675–0·07 mm. in length and 0·0425–0·06 mm. in width. The oesophagus is, as in *Camallanus*, composed of a muscular anterior portion and a long glandular posterior portion. The distance from the head-end to the posterior end of the muscular portion is 0·4 mm. in the male and 0·47 mm. in the female. The length of the entire oesophagus, measured from the extremity of the head, is 1 mm. in the male and 1·25 mm. in the female. The nerve-ring is situated at 0·175–0·2 mm., and the excretory pore at 0·43 mm. (female) from the anterior end.

In the male, the tail is 0·037 mm. long. There are nine pairs of rib-like preanal papillae (occasionally there may be eight or ten papillae on one side and nine on the other). One pair of papillae, similar to the preanal papillae, is situated laterally at the level of the cloaca. There are also, apparently, two

very small pairs at the sides of the cloacal aperture, situated subventrally and one behind the other; and two or three very small pairs of postanal papillae, which can only be made out with great difficulty. The left spicule measures 0·05 mm. in length, the right 0·15 mm. No accessory piece has been seen.

The tail of the female is conical and tapering, and ends in three very short, blunt processes. It measures 0·15 mm. in length. The vulva, which has a prominent anterior lip, is situated somewhat in front of the middle of the body (at 7 mm. from the anterior end in a specimen 15·5 mm. long). The vagina is at first narrow, and runs back, rather sinuously, for about 1·1 mm. before opening into the uterus. For a short distance posteriorly it gradually widens out. As in *Camallanus*, there is only a single ovary. The posterior uterus ends blindly at about 1·4 mm. from the posterior end. The coils of the ovarian tube belonging to the anterior uterus extend to a point 0·4–0·9 mm. behind the junction of the oesophagus and intestine. The worm, like the species of *Camallanus*, is viviparous.

A tube in the named collection (No. 58), bearing the label "*Cucullanus laeviconchus*," from *Pimelodus schaal*, contains only a few fragmentary specimens belonging to a species of quite a different type, and apparently not a Camallanid. The condition of these specimens unfortunately makes identification impossible.

Procamallanus spiralis, sp. n.

(Fig. 3.)

The tube (No. 411) containing *Camallanus cyathopharynx*, from *Heterobranchus anguillaris*, also contained a single male specimen of a very remarkable form. This approaches closely to the preceding species in the possession of a buccal capsule which has a continuous wall and is not divided into two lateral valves, and in the absence of tridents. The inner surface of the wall of the buccal capsule, however, is provided with ridge-like thickenings which traverse it in a spiral fashion (Fig. 3). The head is slightly compressed from side to side. The total length of this unique specimen is slightly over 7 mm., and its greatest thickness about 0·16 mm. The length of the buccal cavity is 0·07 mm. The distance from the head-end to the end of the anterior, muscular portion of the oesophagus is 0·45 mm., and the total length of the oesophagus, measured from the anterior extremity, is 0·78 mm. There are two spicules, of which the right measures about 0·15 mm. and the left about 0·1 mm. in length. The cuticle of the posterior end is rather damaged, and the caudal papillae have not been made out.

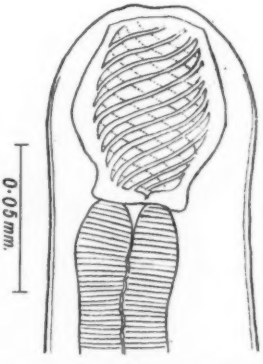

Fig. 3. *Procamallanus spiralis.* Head; lateral view.

The spiral thickenings of the mouth-capsule in this species are an instance of a very rare condition among nematodes. They may be compared with the structure of the wall of the pharynx of *Arduenna strongylina*.

Family CUCULLANIDAE Barreto, 1916 [Stossich, 1898, *fide* Ward and Whipple].

Syn. *Dacnitidae* Lane, 1916 (*nec Cucullanidae* Diesing [?] = *Camallanidae* Raill. and Henry, 1915).

Genus **Cucullanus** Müller, 1777[1].

Syn. *Dacnitis* Duj., 1845, *nec Camallanus* Raill. and Henry, 1915.

Cucullanus carettae, sp. n.

(Figs. 4–8.)

533. From stomach and intestine of *Thalassochelys caretta* [*T. corticata*].

This form is represented by a number of well-preserved specimens of both sexes. The males measure about 12–14 mm. in length, the females about 14–15 mm. The maximum thickness of the body, which is cylindrical and not

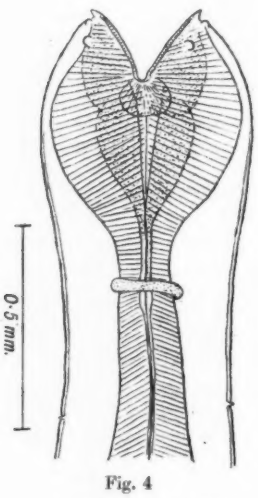

Fig. 4

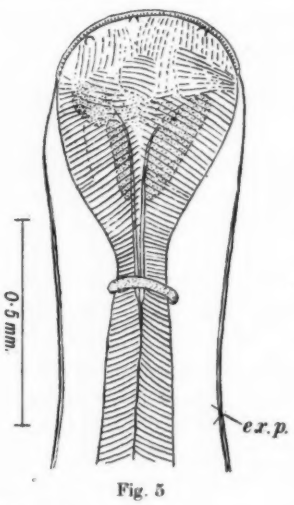

Fig. 5

Fig. 4. *Cucullanus carettae*. Head of female; dorsal view.
Fig. 5. *Cucullanus carettae*. Head of female; lateral view.

laterally flattened, varies between 0·43 and 0·53 mm. The cuticle is transversely striated at intervals of about 5 μ. The dorso-ventral diameter of the head, at the level of the submedian papillae, is 0·32–0·37 mm. There is no curvature of the head towards the dorsal side, the neck being quite straight. The anterior

[1] The date is given as 1774 in Stiles and Hassall, *Index-Cat. Med. and Vet. Zool.*, Roundworms. This is probably copied from Sherborn, *Index Animalium*, 1902, where there is a misprint.

portion of the oesophagus is widened out, in the manner usual in the group, to form a muscular "false buccal capsule." The walls of this structure show numerous masses of muscles with their fibres running in different directions (Fig. 5). The two large lateral lips are bordered by a narrow cuticular membrane bearing, on its inner surface, a row of numerous small, anteriorly-directed, tooth-like structures. The oesophagus is entirely muscular, ending posteriorly in a club-shaped enlargement, but without a specialized bulb or glandular portion. The length of the oesophagus, measured from the anterior extremity

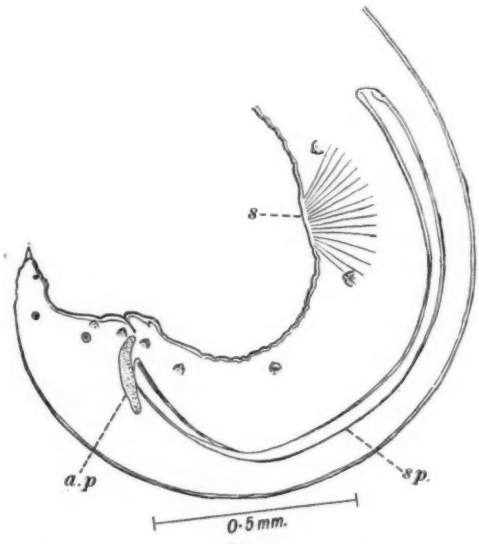

Fig. 6

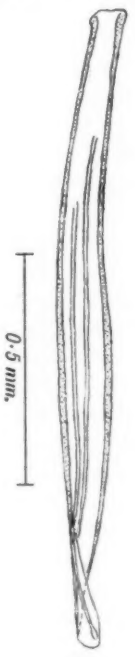

Fig. 7

Fig. 6. *Cucullanus carettae.* Caudal end of male; lateral view. *a.p.*, accessory piece; *s.*, sucker-like organ; *sp.*, left spicule. Fig. 7. *Cucullanus carettae.* Right spicule; ventral view.

of the head, is 1·5–1·7 mm., and its greatest diameter is 0·3–0·32 mm. The cervical papillae are situated at 1–1·05 mm., the nerve-ring at 0·6–0·7 mm., and the excretory pore at 1–1·1 mm., from the anterior end.

The tail of the male (Fig. 6) is about 0·3 mm. long. It is curled ventrally, conically tapering in shape, and without alae. There is a sucker-like aggregation of muscles (Fig. 6, *s.*) on the ventral side, fan-shaped in lateral view, at some distance in front of the cloaca. This structure is not a true sucker, having no definite cavity or aperture. It is possible that the contraction of the muscles might cause a depression of the cuticle, which would then have the appearance of a sucker.

The caudal papillae (Fig. 6) are arranged in ten pairs, of which five may be said to be postanal and five preanal. The second and third of the postanal series, counting from the extremity of the tail, are situated laterally, the rest subventrally. The most anterior of the preanal series is situated just in front of the "sucker," the next just behind it. The two equal spicules (Figs. 6, *sp.*, 7) measure 1·4–1·5 mm. in length. They are broad, dorso-ventrally flattened structures. Their free ends are membranous and twisted in a characteristic manner. When flattened out, the membrane is seen to end as if cut off nearly square at the tip of the spicule. It is supported by two rib-like thickenings which run down the greater part of the length of the spicule, one of them terminating in a slight knob-like expansion, the other in a point. There is a slipper-shaped or tongue-shaped accessory piece (Figs. 6, *a.p.*, 8), measuring about 0·25 mm. in length and apparently bifid at its proximal, or dorsal, end.

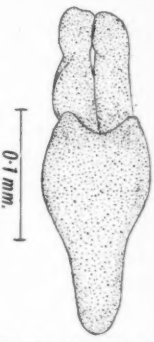

Fig. 8. *Cucullanus carettae.* Accessory piece; ventral view.

In the female the conically-tapering tail measures 0·3–0·36 mm. in length. There is a small pair of caudal papillae, situated in deep dimples of the cuticle, at 0·14–0·19 mm. from the tip. The vulva is situated at about 4 mm. from the posterior end, dividing the body in the proportion of, roughly, 5 : 2. Its anterior lip is slightly prominent. The vagina, together with the unpaired portion of the uterus, runs straight forward for a distance of about 2 mm. before giving off the two uterine branches, which are directly opposed. The eggs are roundish-oval, and have thin shells measuring about 0·087 × 0·057 mm. Their contents are segmenting at the time of laying.

NOTE ON THE SYSTEMATIC POSITION OF *CUCULLANUS*, AND ON THE FAMILIES CUCULLANIDAE AND CAMALLANIDAE.

Great confusion persisted in the literature for many years between the forms included under the names *Cucullanus* and *Dacnitis*. Railliet and Henry (1915) cleared up the situation, in part, by showing that the type-species of the original genus *Cucullanus* of O. F. Müller, 1777, is *C. cirratus* Müll., and that this differs entirely from the forms assigned by Dujardin and more recent authors to *Cucullanus*, but corresponds to Dujardin's genus *Dacnitis*. They therefore concluded that the species at present assigned to *Dacnitis* should properly be called *Cucullanus*, *Dacnitis* falling into synonymy. For the forms called *Cucullanus* by Dujardin and others they proposed the new name *Camallanus*. These were raised to the rank of a family, Camallanidae. "*Dacnitis*" (*Cucullanus* Müller) was regarded by these authors as a member of the family Heterakidae, on the ground of the presence of a "sucker" in the male.

A family Dacnitidae was proposed and diagnosed by Lane (1916), to include "*Dacnitis*" and two new genera, *Serradacnitis* and *Bulbodacnitis*. Although Lane did not indicate the position of this family among the Nematoda as a

whole, he was of the opinion that the possession of a "sucker" was, by itself, not a satisfactory reason for grouping these forms with the Heterakidae, from which, in other respects, they differ markedly. In this he was, in the writer's view, undoubtedly right, since even if the characters of the lips alone be considered, it seems impossible to place forms with two exceedingly well-marked lips, such as are found in the "*Dacnitis*" group, in the same family with three-lipped genera.

The family name Dacnitidae, however, must stand or fall with the name of the type-genus, and since it has been shown by Railliet and Henry, as already stated, that *Dacnitis* is a synonym of *Cucullanus*, it follows that the family name must be Cucullanidae. This has been pointed out by Barreto (1916), who gives a fresh family diagnosis[1]. Barreto's family, according to Travassos (1920 [?]), includes the genera *Cucullanus*, *Haplonema* and *Spiroxys*, while this author has proposed a further family, Dacnitoididae, to include the genus *Dacnitoides* Ward and Magath, 1917, of which the type and only species is *D. cotylophora* Ward and Magath. The three families Camallanidae, Cucullanidae and Dacnitoididae are placed together by Travassos in a superfamily Camallanoidea.

In the writer's opinion the status of these several groups, and of the collective group Camallanoidea, is far from satisfactory. The very brief diagnosis of the superfamily Camallanoidea given by Travassos runs as follows (the original being freely translated):

"Mouth bivalved, provided with two chitinous 'shells'; oesophagus consists of two parts of similar structure; may or may not be viviparous; a preanal sucker present or absent."

Now the last two clauses in this diagnosis, each embodying, as it does, two alternatives, are clearly valueless in defining a group. The statement that the mouth has two chitinous "shells" holds good for the Camallanidae, but not for the Cucullanidae (Dacnitidae) or for *Dacnitoides*. It is not quite clear what is meant by the division of the oesophagus into two "similar" parts. The oesophagus is distinctly divided into a muscular and a glandular portion in the Camallanidae, but not in the other forms. The only common feature remaining is the bivalved mouth, and this is shared by the vast majority of forms included in the much more firmly-established superfamily Spiruroidea.

Taking now the family Cucullanidae, Barreto, this is defined as follows by Travassos:

"Mouth large, without the typical chitinous valves; oesophagus with the anterior portion much reduced; preanal sucker present or absent; without an intestinal diverticulum."

The inclusion of the genus *Haplonema* in this group seems unjustifiable, since it is without lips or buccal cavity, and lacks the large mouth mentioned.

[1] Since the preparation of this paper there has come to hand a fuller account of the family by Barreto (1922. *Mem. Inst. Oswaldo Cruz*, XIV. p. 68). This author includes in the family *Cucullanus* and *Dacnitoides*, but does not accept *Serradacnitis* and *Bulbodacnitis* as of generic rank.

As regards *Spiroxys*, Baylis and Lane (1920) have expressed the view that it should be placed in the family Gnathostomidae. It certainly approaches at least as closely to the other genera of that family as to *Cucullanus*. Of the genera included by Travassos, we are therefore left with *Cucullanus* only. To this, however, must be added *Serradacnitis* and *Bulbodacnitis* Lane, if these are accepted as "good" genera. In the writer's opinion *Dacnitoides* should also be included in the same group. The only reason for erecting a separate family for its reception seems to have been the presence of an intestinal caecum, and this, taken by itself, seems scarcely to warrant such a procedure.

The family diagnosis given by Lane (1916) for the "Dacnitidae" is as follows:

"Polymyaire nematodes flattened from side to side. The cephalic end bent dorsad. The mouth, a slit running dorso-ventrad, each lip carrying the usual three papillae. The mouth opening into a false oral cavity formed by the dilatation of the cephalad end of the oesophagus. The oesophagus *en massue*, without bulb. The males with eleven pairs of caudal papillae, a preanal sucker without cuticular ring, equal spicules accompanied by an accessory piece. The female with the vulva near the middle of the body, the vagina running cephalad, and dividing into two parallel cephalad-running uteri, and the ovum with a clear thin shell containing a segmented yolk of granular appearance separated from the shell by a space."

This diagnosis is, in the main, identical with that given by Railliet and Henry (1912) for the genus "*Dacnitis*." With certain reservations, it fits the genera *Cucullanus*, *Serradacnitis*, *Bulbodacnitis* and *Dacnitoides*. The lateral flattening, the dorsal bend of the head, the presence of eleven pairs of caudal papillae in the male, the median position of the vulva and the parallel arrangement of the uteri are clearly not universal characters (see description of *Cucullanus carettae*, above). As regards the female, the diagnosis appears to have been based on *Bulbodacnitis*, since Lane had no females of *Serradacnitis*, and had been unable to obtain *Dacnitis* for comparison.

Before leaving the discussion of this group, it seems relevant to point out the striking resemblance between the genera already mentioned and the genus *Seuratum* Hall, 1916, represented by *S. tacapense* (Seurat, 1915). This form, which occurs in a rodent, and not in a fish or reptile, has been designated by Hall as the type of a subfamily Seuratinae, which is placed in the family Heterakidae, and is defined by Hall (1916) as follows:

"Transitional forms in which the male is without an anal sucker. Mouth with two lips. No oesophageal bulb present. Male with short, equal or subequal spicules, and with a gubernaculum. Vulva near middle of body. Uteri divergent."

It has already been pointed out that there is strong reason for doubting the close relationship of the two-lipped Cucullanidae with the three-lipped Heterakidae. This argument, especially when taken in conjunction with the

absence of a sucker, seems to apply equally well to the form now under discussion. The writer feels, in fact, that *Seuratum*, even if regarded as a "transitional form," might, on morphological grounds, be considered more closely related to the Cucullanidae than to the Heterakidae. It might be regarded as a *Cucullanus* in which the "false buccal cavity" and the "sucker" have not reached the typical degree of development or have been suppressed[1].

To sum up the results of the foregoing discussion, the diagnosis of the family Cucullanidae (*s.s.*) might be emended to run somewhat as follows:

Spiruroidea: Polymyarian. Head sometimes bent dorsally. Mouth a dorso-ventral slit, with two large lateral lips, each bearing three papillae. Oesophagus muscular throughout, enlarged into a club posteriorly, but without bulb or distinct glandular portion, and usually having its anterior end dilated to form a large, muscular, "false buccal cavity," without chitinous lining or valves. Male with two equal spicules and usually an accessory piece. A preanal sucker-like organ usually present. Vulva near middle of body or behind it. Vagina runs anteriorly. Oviparous.

Type-genus, *Cucullanus* (= *Dacnitis*), with the characters of the family.

The following other genera might be included, and distinguished from *Cucullanus* as follows:

Cuticular serration present in addition to the usual striation. *Serradacnitis.*

A swelling or tubercle present on the dorsal side of the head. *Bulbodacnitis.*

Accessory piece of male absent. Posterior uterine branch ends blindly (as in Camallanidae), without ovary. An intestinal caecum present. *Dacnitoides.*

Sucker-like organ of male absent. Anterior end of oesophagus not markedly dilated. . . . . *Seuratum.*

Until more species have been adequately described, it appears useless to attempt to define more clearly the relationships between these forms. A division into two subfamilies, retaining Seuratinae for *Seuratum*, may subsequently prove to be desirable.

Turning now to the family Camallanidae, the definition of this group is at present that of its type-genus, *Camallanus* Railliet and Henry, 1915. This will still hold good, with a few slight modifications due to the inclusion of two new genera, viz. *Camallanides*[2] and *Procamallanus* (see above).

An emended diagnosis would be somewhat as follows:

Spiruroidea: Polymyarian. Body usually red during life. Mouth a dorso-ventral slit. Buccal cavity with chitinous armature consisting of either two lateral *Pecten*-shell-like valves or a continuous capsule. Oesophagus composed of an anterior muscular portion and a long, posterior, glandular portion.

[1] The position of *Maupasina* Seurat, 1913, among the Heterakidae also seems a little uncertain for somewhat similar reasons.

[2] Baylis and Daubney, Report on the Parasitic Nematodes in the Collection of the Zoological Survey of India. *Mem. Ind. Mus.* (in press).

Caudal end of male curled ventrally, thickened and with lateral alae. Caudal papillae variable in number, mostly pedunculate and projecting into the alae. Two spicules, unequal and dissimilar. Female much larger than male. Vulva usually prominent and situated near middle of body. Vagina runs posteriorly. Branches of uterus directly opposed, the posterior branch ending blindly and without an ovary. Viviparous.

Type-genus, *Camallanus*. In this genus there are simple, paired chitinous buccal valves, with longitudinal rib-like thickenings internally; a chitinous ring at the junction of the buccal valves and oesophagus; and, opposite to the dorsal and ventral edges of the valves, a pair of trident-shaped chitinous structures connected with the muscles which operate the valves.

The other genera may be distinguished as follows:

Paired buccal valves as in *Camallanus*, but each with two large thickenings externally. "Tridents" reduced to simple, rod-like structures. Vulva situated near the end of a tubular appendage. . . *Camallanides.*

Buccal armature a continuous chitinous capsule, not separated into paired lateral valves, the wall of which may be smooth or provided with spiral thickenings internally. . . . . *Procamallanus.*

The two families thus defined may, for the present, be referred to the superfamily Spiruroidea, since, as has been pointed out above, they do not appear to be more closely related to each other than to any other family of Spiruroidea, and there seems, therefore, to be little ground for the erection of the separate group, Camallanoidea.

Superfamily **ANGIOSTOMOIDEA** Hall, 1916.

Syn. *Rhabdiasoidea* Raill. and Henry, 1916.

Family ANGIOSTOMIDAE Braun, 1895.

Syn. *Rhabdiasidae* Raill., 1915.

Genus **Angiostoma** Duj., 1845.

Syn. *Rhabdias* Stiles and Hassall, 1905.

Angiostoma bufonis (Schrank, 1788).

Syn. *A. nigrovenosum* (Goeze, 1800).

424. From *Rana temporaria*. Locality, Leipzig.
426. From lungs of *Bufo vulgaris*. Locality, Leipzig.
417. From lungs of toad. Locality, ? Egypt.
425. From lungs of frog. Locality, Egypt.

Genus **Strongyloides** Grassi, 1879.

Strongyloides stercoralis (Bavay, 1876).

414. From a monkey—[apparently a culture from the faeces].

This material consists of a large number of adult male and female forms of the free-living generation. These agree in general characters and measurements with the free-living generation of the form occurring in man.

At least two other species have been described as occurring in monkeys. *S. fulleborni* v. Linstow, 1905, has been recorded from *Anthropopithecus* and *Cynocephalus*. In this form, the body of the free-living female is said to be suddenly constricted in the post-vulvar region. The uterus is also stated not to contain more than eight eggs at a time, whereas that of *S. stercoralis* may contain forty or more, and there are other slight differences.

S. cebus Darling, 1911, from *Cebus hypoleucus*, differs more markedly from *S. stercoralis* in the parasitic than in the free-living generation. The parasitic female is apparently about half as long again as that of *S. stercoralis*, while the eggs are considerably larger. In the description of the free-living generation, however, there are also some differences from *S. stercoralis*, the chief of which is the greater absolute and relative length of the oesophagus in *S. cebus*.

Rhabditis tripartita v. Linstow, 1906, found in the faeces of a monkey, appears to be quite distinct from, though in some respects similar to, the form under discussion. The characters of the tail of the male seem to be quite different.

415, 412, 420, 421, 423. From *Eryx jaculus*. Locality, Egypt.

Tube No. 421 contains filariform females of the parasitic generation of a *Strongyloides* (labelled "*Rhabdonema erycis*" by Looss) which differs in no way, as far as can be judged, from *S. stercoralis*. Nos. 412, 420, 423 contain portions of the oesophagus of *Eryx jaculus*, also labelled "*Rhabdonema erycis*," but no specimens of the worm have been found in them except a few adhering to the lining of the piece of oesophageal wall in No. 420. These resemble No. 421.

No. 415 appears to be a culture of the faeces of *Eryx*, and contains a large number of rhabditiform males, females and larvae of the free-living generation, again indistinguishable from the corresponding forms of *S. stercoralis*.

The occurrence of a species apparently identical with the human parasite in so widely different a host as a snake seems very remarkable. If, however, *Strongyloides* is capable of living in hosts so distantly related, it is not difficult to account for the occasional infection of such an animal as *Eryx jaculus*. This snake not only burrows in sandy soil, but (as the writer is informed by Dr G. A. Boulenger, F.R.S.), also inhabits the more loamy parts of the Nile Delta, and may be found in the immediate neighbourhood of human habitations on the outskirts of Cairo.

It may be that *Strongyloides* (as is perhaps suggested by the persistence of the free-living bisexual generation) has not yet become confined, like most parasitic nematodes, to a limited range of hosts by special adaptation for a parasitic existence.

416. The label apparently reads "*Rhabdonema*. M. D. Otitide Schuldach. 24. vii. 97. A." The material consists of three specimens of the parasitic form (filariform female) of a *Strongyloides* which, again, seems indistinguishable from *S. stercoralis*. The meaning of the label is not clear, but it seems just possibly to indicate that the host was a bird of the family Otididae (Bustards),

taken on the roof of the School [? of Medicine]. Should this conjecture be correct, it would seem to bear out the suggestion made above as to the adaptability of *Strongyloides* to a varied range of hosts.

NOTE ON THE AFFINITIES OF *PROBSTMAYRIA VIVIPARA* (PROBSTMAYR, 1865)

The collection includes a tube (No. 471) containing large numbers of well-preserved specimens from the colon of a horse, labelled "*Oxyuris hyalina*" by Looss. This name has not, so far as the writer is aware, been published, and the specimens in question are undoubtedly *P. vivipara*.

The systematic position of this species has not, as it seems to the writer, been satisfactorily established. It has been variously referred to the genera *Oxyuris*, *Rhabdonema*, *Strongyloides* and *Anguillula*, belonging to the families Oxyuridae, Angiostomidae and Anguillulidae. Ransom (1907), to whom we owe the most complete account of its morphology, erected for it the new genus *Probstmayria*, but refrained from indicating the relationships of the genus to others. Travassos (1920 [?]) has placed *Probstmayria* in a subfamily Oxysomatinae of the family Oxyuridae.

While examining the present material, the writer was greatly struck by the resemblance of this species, especially in the structure of its oesophagus, to some of the forms contained in the family Kathlanidae. The mouth, as Ransom has shown, leads into a tubular pharynx. The posterior part of this pharynx is muscular, with a cuticular lining. A small anterior portion has walls composed of cuticle only. The pharynx is followed by a cylindrical, muscular oesophagus, and finally there is a bulb of characteristic shape, having a large posterior swelling (containing the valvular apparatus) and a smaller anterior swelling, separated from the former by a distinct neck. Now these characters are closely paralleled among the Kathlanidae in the genus *Falcaustra*, and perhaps still more closely in certain forms allied to *Falcaustra*, which have been placed in a genus *Zanclophorus*[1].

Ransom interprets the structures surrounding the mouth as six lips, of which two are lateral, two dorsal and two ventral, and says that each of the dorsal and ventral lips bears a papilla in relation with a "filament" passing through the lip. The writer's own investigations lead to the belief that there are, in reality, only three lips, each being somewhat bilobed in shape. Thus the two dorsal lips of Ransom's description are the two halves of the single dorsal lip, while his two lateral lips are the lateral, and his ventral lips the ventral, halves of two ventro-lateral lips. The dorsal lip carries two papillae with long peduncles passing up through the lip, while each ventro-lateral lip carries one such papilla on its ventral half. Even with the aid of an oil-immersion objective, it has not been possible to detect papillae on the lateral halves of these lips. They may, however, be present, as the very small size of the head makes it extremely difficult to resolve the details. Whether, as in

[1] Baylis and Daubney, *l.c.*

Falcaustra, the pulp of each papilla sends a branch to a small subsidiary papilla on the inner surface of the lip, it has not been possible to make out.

The rest of the anatomy of *P. vivipara* tends to bear out its suggested relationship to *Falcaustra* and its allies. Thus, the male has two short, equal spicules and a simple, tapering tail without alae, while in the female the two branches of the uterus are opposed. The viviparity of the species is probably a special development which is not a bar to its inclusion with oviparous forms. On the whole, therefore, the writer is inclined to believe that the genus *Probstmayria* should be placed in the family Kathlanidae Travassos, 1918.

It should be pointed out that the type-genus of Travassos' subfamily Oxysomatinae, mentioned above, is *Oxysomatium* Railliet and Henry, 1913 (genotype *O. longespiculum* Raill. and Henry, 1916 [= *Oxysoma brevicaudatum* Schneider, 1866]), and not *Oxysoma* Schneider, 1866. The other species included by Schneider in his genus *Oxysoma* (*O. tentaculatum* (Rud.) and *O. lepturum* (Rud.)) have much greater affinities with *Probstmayria* than has *O. brevicaudatum*, being both probably referable to the Kathlanidae. *O. tentaculatum* has been designated as the type of a genus *Cruzia* by Travassos, while *O. lepturum* is a *Kathlania*. *Cruzia* is placed by Travassos in a separate family, Cruzidae, but it is difficult, on comparing it with *Kathlania*, to realize the justification for this step.

APPENDIX.

ACANTHOCEPHALA.

Family ECHINORHYNCHIDAE Cobbold, 1879.

Genus **Acanthocephalus** Koelreuter, 1771.

Acanthocephalus ranae (Schrank, 1788).

537 (part). From *Rana temporaria*. Locality, Leipzig.

536. From frog. Locality, Leipzig.

Genus **Corynosoma** Lühe, 1904.

Corynosoma strumosum (Rud., 1802).

504 (part). From *Halichoerus grypus*. Locality not given.

Family GIGANTORHYNCHIDAE Hamann, 1892.

Genus **Oligacanthorhynchus** Travassos, 1915.

Oligacanthorhynchus sp. (?)

459 (part). From *Agama stellio* [*Stellio vulgaris*]. Locality, Aboukir.

The species of this genus occur as adults in birds, chiefly in birds of prey. The larval forms, so far as they are known, occur encapsuled in the peritoneum of snakes. There is no indication as to the position of the present specimen (an immature one) in the host. It occurred in a tube containing *Thelandros cinctus* from the rectum.

Fam. and Gen. *incert.*

Larval Acanthocephala.

446 (part). From "toad" (encysted), according to the label.

The other material in the same tube was identified as *Thelandros bulbosus*, var. *annulatus*. The host has almost certainly been wrongly indicated, and in all probability should be *Chalcides ocellatus*, and not a toad.

The larvae of species of *Centrorhynchus* are said to occur in lizards, and a few other larval Acanthocephala have been recorded from them. The larva of *Centrorhynchus aluconis* (Müll.) is also recorded from frogs.

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A JUSTIFICATION OF *POROCEPHALUS POMEROYI*, WOODLAND, 1921.

By W. N. F. WOODLAND, D.Sc. (London).

Wellcome Bureau of Scientific Research, London.

(With Text-figs. 1–3 *D.*)

In January, 1921, I published in *Parasitology* (Vol. xii. No. 4, p. 337) a brief description of what appeared and still appears to me to be a new species of *Porocephalus*, and I commented upon the fact that this species exhibited "the most marked form of sexual dimorphism yet discovered in the Linguatulidae" and is therefore of some interest. Two writers have recently questioned the validity of this new species. Alcock[1] suggests the possibility of my female specimen of *Porocephalus pomeroyi* being an individual abnormality, and Sambon[2] unhesitatingly decides that its peculiar form is merely due to "constriction" and deformity, and records the species as a synonym of his "*Armillifer annulatus*"—the *Pentastoma* (*Porocephalus*) *annulatum* of Baird, 1853.

In 1920 I was unaware of the existence of more than one known example of *P. pomeroyi*, but Miss Hett, having informed me last year that two other specimens were contained in the British Museum (Natural History) collection, I recently examined these, and, by the courtesy of Mr A. S. Hirst, made the drawings reproduced in Figs. 1 and 2.

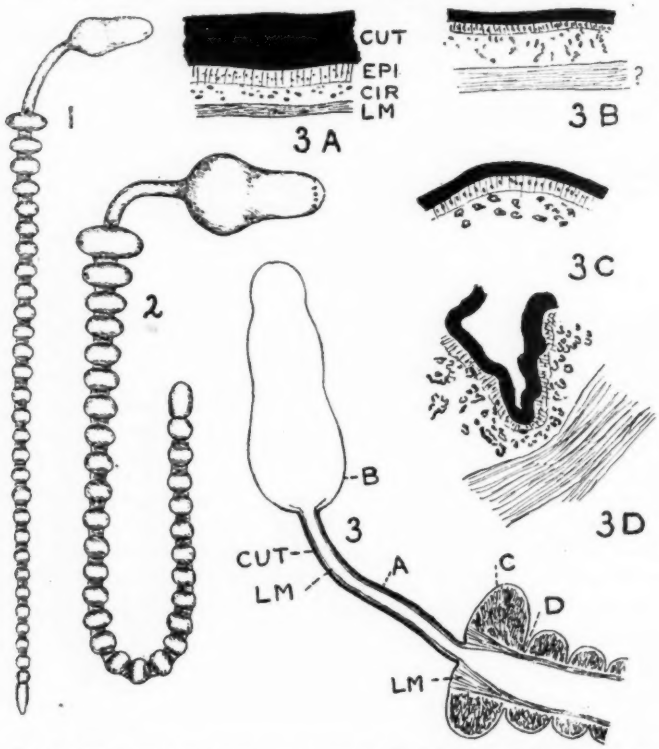
In the first and smaller of these two female specimens (Fig. 1) the prosoma measured 5·7 mm. in length and 2·7 mm. in maximum breadth, the neck was 6 mm. long and 0·8 mm. broad, the first annulus was 2·8 mm. broad and 1·2 mm. long, the second annulus was 2 mm. broad and 1 mm. long, an annulus situated midway in the length of the body was 1·3 mm. broad and 1 mm. long, the terminal "segment" was 2 mm. long. The entire specimen measured 51·9 mm. in length and contained 29 annuli plus the terminal segment.

In the second and larger specimen (Fig. 2) the prosoma measured 9·5 mm. in length and 5·3 mm. in its maximum breadth, the neck was 6·5 mm. long and 0·9 mm. broad, the first annulus was 4·3 mm. broad and 2 mm. long, the second annulus was 3·3 mm. broad and 1·7 mm. long (excluding the interannular space), the breadth of a midway-situated annulus was 1·5 mm., the length of the terminal segment was 2 mm. and the breadth 1·5 mm. and was somewhat rounded terminally. The entire specimen measured 71 mm. in length and, as in the former specimen, contained 29 annuli plus the terminal segment. These two specimens were found in the lungs of *Naja* sp. (*melanoleuca*?) from Sierra Leone, according to the label on the bottle.

[1] *Tropical Diseases Bulletin*, Vol. xviii. No. 1, July 1921, p. 30.

[2] *Journ. Trop. Med. Hyg.* Vol. xxv. No. 12, June 1922, p. 203.

Comparing these two specimens with the one I originally described, it may be recalled that in the last the entire animal measured 64 mm. in length, the prosoma 8 mm., the neck 7 mm. and the opisthosoma contained 31 annuli



Figs. 1 and 2 (× 2·25). Two female specimens (more or less straightened) of *Porocephalus pomeroyi* from the British Museum (Natural History) collection.

Fig. 3 (× 4·5). Semi-diagrammatic sagittal section through the original type-specimen of *P. pomeroyi* to show the thickness of the cuticle in the anterior region of the body and the "packing" of the first three annuli.

Figs. 3 *A*, *B*, *C*, *D* (× 84). Sections through the body-wall of the type-specimen at the positions indicated by the corresponding letters in Fig. 3. In *B* I am uncertain concerning the exact thickness of the layer of longitudinal muscle owing to the crumpled condition of the prosoma, and in *D* only a part of the longitudinal muscle layer shown enters the neck. The condition of the cuticle and circular muscle layer in *A* shows that the neck is not in a constricted condition.

CIR, circular muscle layer; *CUT*, cuticle; *EPI*, epidermis; *LM*, longitudinal muscle layer.

plus the terminal segment. This original specimen was found in the mid-intestine of *Naja nigricollis*, Reinh., from South Nigeria.

Finally, Sambon[1] figures a specimen in which the neck is thicker than usual and is apparently longer than the prosoma (the latter region, however, is

[1] *T. cit.* p. 201.

evidently much distorted[1]) roughly in the proportion of 4 : 3, but which is otherwise similar to the three specimens already described.

From the data I have supplied concerning three of these four specimens, we can diagnose the species by the following characters. Adult female: body white, cylindrical, ranging from about 50–71 mm. in length and divided distinctly into (1) a large sacciform prosoma, narrower in front than behind, the length of which is at least equal to the combined lengths of annuli (plus the interannular spaces) 6–9 inclusive, *i.e.* the first four annuli after annulus 5, (2) a long thin neck, which in length is at least more than half that of the prosoma, and (3) an opisthosoma consisting of from about 29–31 annuli plus a terminal segment, the length of which last is twice that of the preceding annulus. The first annulus of the opisthosoma is considerably broader and thicker than any succeeding annulus. The interannular spaces are normally (in preserved specimens) not more than half the length of adjacent annuli, and are usually much less. Adult male: about 12 mm. long, *i.e.* about one-fifth the length of the female, and the body is only divisible into a small prosoma (continuous in contour with the opisthosoma) of the usual Porocephalid type, and an opisthosoma, also of the usual type, consisting of about 36 annuli plus the terminal segment. A neck is absent. The terminal segment is twice the length of the preceding annulus. Habitat: lungs of *Naja* sp. (*melanoleuca*?), Sierra Leone, and intestine of *Naja nigricollis*, South Nigeria.

From the descriptions supplied by Baird[2], Harley[3], Shipley[4] and Sambon[5] the chief characters of *P. annulatus* are as follows. Adult female: body white, cylindrical, ranging from 80–121 mm. in length, and divided into (1) a prosoma, obtuse in form, broader in front than behind, and not exceeding in maximum length the combined lengths of any two annuli and two interannular spaces posterior to annulus 5, (2) a short narrow neck which in length never exceeds one-eighth the length of the prosoma, and (3) an opisthosoma consisting of from about 26–30 annuli plus a terminal segment. The first annulus is always less broad and less thick than succeeding annuli. The interannular spaces are (in preserved specimens) at least equal in length to the annuli. Male: 25–29 mm. in total length (*i.e.* about one-quarter the length of the female), and consisting of about 29 annuli plus the terminal segment. Other characters apparently similar to those of the male of *P. pomeroyi*.

From the above largely provisional diagnoses of the two species, it will be seen that, quite apart from the peculiar form of the female in *P. pomeroyi*, the female of this species also differs from the female of *P. annulatus* in possessing a distinctly smaller body (shorter by some 40 mm. on the average, and of less average breadth in proportion), in possessing, relative to the thickness of the annuli, much shorter interannular spaces, and three or four more annuli;

[1] The thin-walled, largely-hollow, prosoma is very liable to artificial distortion. Thus, when I cleared the type-specimen in creosote the prosoma lost its "plump" outline and became much crumpled.

[2] *Proc. Zool. Soc. London*, Pt XXI. 1853, p. 22.

[3] *Ibid.* Pt XXV. 1857, p. 115.

[4] *Arch. de Parasitol.* T. 1, No. 1, 1898, p. 52.

[5] *Loc. cit.*

and the male of *P. pomeroyi* (judging from one specimen I have described, which was certainly adult, since it was discovered *in coitu*) is about half the length (about 12 mm.) of the male of *P. annulatus* (25–29 mm.).

The fact that there are certainly three specimens known of the female of *P. pomeroyi* (four, if we include that figured by Sambon) is a sufficient reply to the suggestion made by Alcock that my type-specimen was an individual abnormality.

The similar suggestion made by Sambon that my species is the end-term, so to speak, of a series of natural deformities which, according to him, afflict this particular species, *P. annulatus*, cannot be considered seriously until concrete evidence of the existence of this series is produced, especially since, so far as I am aware, other species of Linguatulids show no such extreme variations in shape. The one "abnormal" specimen Sambon has figured[1] is not a form which can be considered in any way intermediate between *P. pomeroyi* and *P. annulatus*, if we allow for the obvious shrinkage and distortion of the prosoma of what is evidently a fourth specimen of the former species.

The further suggestion of Sambon to the effect that the thin neck of *P. annulatus* and the much longer, though no thinner, neck of *P. pomeroyi* are due to "constriction," effected by the parasite in its efforts to penetrate deeply into the tissues of its host, is also shown to be of very doubtful value (1) by the absence of intermediate degrees of constriction in the known specimens of these species and in other genera and species of Linguatulids, (2) by the fact that two of my specimens were found in the lungs—organs easily penetrable by other species without such extensive constriction—and the third in the intestine, with its prosoma and neck not buried in the intestine wall, and (3) by the fact that longitudinal sections which I have made through the prosoma, neck and first three annuli of my type-specimen show that *the cuticle of the neck region is three times as thick as the cuticle on any other part of the body* (cf. Figs. 3 *A*, *B*, *C*, *D*), that the circular muscles in the neck are not more contracted than those in the joints separating the annuli, and that the large size of the first and second annuli is natural, judging by the amount of the connective and other tissue occupying their cavities. I may add that the ducts only of the hook-glands extend through the neck and that the size of the first two annuli may be correlated with the unusually large size of the two spermathecae.

To sum up, three, possibly four, female specimens of *P. pomeroyi* are known to exist, all essentially similar and markedly distinct from the females of *P. annulatus*. The shape of these female *P. pomeroyi* is not due to a temporary constriction or expansion of the body, as supposed by Sambon, and, unless it can be shown that intermediate varieties exist, cannot be regarded as due to mere variation or as teratological. Until evidence is produced to the contrary, *P. pomeroyi* and *P. annulatus* must be regarded as species as distinct from each other as any other two species of Linguatulid belonging to the same genus.

[1] *T. cit.* Fig. *a'* on p. 201.

OBSERVATIONS ON THE MORPHOLOGY OF *RICKETTSIA PROWAZEKI* OCCURRING IN LICE (*PEDICULUS HUMANUS*) INFECTED WITH THE VIRUS OF TYPHUS FEVER[1].

By J. A. ARKWRIGHT and the late A. BACOT.

(*From the Lister Institute of Preventive Medicine.*)

(With Plate I.)

Most of the published descriptions of *R. prowazeki* in lice have dealt with the minute round, oval, diplococcal or dumb-bell forms found by Ricketts and Wilder (1910), Sergent, Foley and Vialatte (1914), da Rocha-Lima (1916), and others.

The size of the smallest form has been variously estimated at about 0·25 to 0·5 × 0·3 to 1 micron, and when it has been found in large numbers considerable variation has usually been noted. Larger individuals apparently formed by the growth in length of their small forms and their cohesion into chains after division, was also noted by Sergent, Foley and Vialatte (1914) and have recently been figured and redescribed by the same authors (1921).

Otto and Dietrich (1917) first figured the chain or thread form, and da Rocha-Lima (1919) states that *R. prowazeki* occasionally has a tendency to grow in short streptococcus-like chains. Wolbach, Todd and Palfrey (1920) refer to thread forms observed in typhus lice in Warsaw, and Weigl, in a personal communication, demonstrated long threads to one of the writers (A. B.) in 1920, but in a recent paper (1921) appears to consider that most of these long and other divergent forms are referable to a new species of *Rickettsia* described by him as *R. rocha-limae*, since he states that *R. prowazeki* is very uniform in size and is in this way distinguishable from the new species.

Occasional forms, larger in all dimensions, have been observed by most workers. Otto and Dietrich (1917) also described larger deeply stained, round, or disc-shaped bodies, occurring in small numbers as a form or stage of *R. prowazeki*.

[1] (Though at the date of printing somewhat similar observations have already been published by other workers, this does not apply to all the varieties of form which are recorded below, nor has the manner of infection of the lice been the same. Moreover, this paper was drafted at the end of 1921 and contains observations made independently of the subsequently published work of Sergent, Foley and Vialatte and of Wolbach and Todd. The publication has been hindered by the illness of the writers and the lamentable death of A. W. Bacot from typhus.—J. A. A.)

Wolbach, Todd and Palfrey (1922) describe and show in finely executed drawings forms of *Rickettsia* from typhus lice, closely resembling most of those which we have observed, but without apparently having seen many or been quite convinced of the nature of those which we have called "chain" and "vacuolated" forms.

Observations by the present writers.

In the following notes the great diversity of form of *R. prowazeki* observed in lice is recorded and certain characters in which the varied morphology resembles that of other kinds of *Rickettsia* is pointed out.

These observations were made in London in 1921 using a strain of typhus virus obtained from Dublin earlier in the same year. The lice examined were for the most part infected with very large numbers of *Rickettsia*. Infection was artificially produced by injecting them with typhus virus through the anus by means of a pipette according to the method originally described by Weigl (1920) and used since 1920 by one of us (A. Bacot) with certain modifications which have been described by Bacot (1922).

At first the material which afforded the virus was obtained by centrifuging the blood of typhus infected guinea-pigs and contained a large number of blood platelets. This platelet material was kindly prepared by Dr Ségal, who has elsewhere recorded his experiments: Bacot and Ségal (1922) and Ségal (1922). Later, some of the lice were injected with virus obtained by dissecting an infected louse, making an emulsion of the gut and adding this to a drop of defibrinated human blood (Atkin and Bacot, VIII. 1922).

Method of examining the lice.

The preparations of lice examined have consisted of carefully teased gut and other organs. The method has been to dissect out the alimentary system in a drop of salt solution, remove the external skin and other organs and then puncture the gut to allow the escape of its contents. The gut was then removed to a fresh drop of saline in which it was thoroughly teased into fragments. In addition to the two smears of gut contents and gut tissue thus obtained the two ovaries have been teased up by themselves after being washed in drops of fresh saline before removal to the final places where the films were made. The salivary glands have in some cases been separated in the same way.

Films of the haemocele fluid, free from the contents of the other organs, have also been obtained by cutting off the louse's legs or making an incision at the last segmental division of the abdomen.

Description of different forms of R. prowazeki.

The reasons for accepting as *Rickettsia* those forms described, which resemble bacteria and are larger than ordinary *R. prowazeki*, are:

(1) Their occurrence in lice which also contain large numbers of the typical forms.

(2) The absence from normal lice of similar forms except for the rare occurrence of a single individual, when this appearance may be readily accounted for by the chance intrusion into the film of a stray bacterium.

(3) The frequent survival for a long time (at least six days after an anal infection) of lice in a healthy condition containing these forms, whereas lice containing many bacteria in the gut usually die rapidly.

(4) Imperceptible gradations are seen between the aberrant forms and typical *Rickettsia*.

For the following descriptions only those forms have been accepted as *R. prowazeki* which appear to us to be well established.

(1) Minute form: this occurs in immense numbers inside cells of the stomach wall and in the lumen of the gut of infected lice. It is the classical form described by Sergent, da Rocha-Lima and others. It appears singly or in pairs as a very minute round or oval body (about 0·3 × 0·3 or 0·5 micron in diameter) or as a slightly longer rod-shaped form (about 0·3 × 1 micron) which often contains dots at the ends, which stain deeply with Giemsa. These and the other forms usually stain a pale lilac or a slightly purplish pink.

It may often be noticed that either the round and oval or the rod-shaped form is present in greatly preponderating numbers.

(2) Larger bacterium-like forms staining deeply at the ends with an unstained intermediate part are often seen. They are usually oval and in diameter two or three or even four times the diameter of the minute forms. Three or more may be placed end to end. These have never been seen in very large numbers.

(3) Threads and chain-forms: these vary very much in length and may appear in all gradations from the minute short rods to threads 50 or more microns in length with a diameter of about 0·3 micron. They sometimes vary also in thickness and the diameter may range from 0·3 to 1 micron in different parts of the same thread. The staining may be uniform and continuous or the thread may be broken up into sections of different lengths with clear internodes. This may give a beaded appearance, sometimes with an enlarged, deeply stained segment, in the course of the thread. Other varieties are more like chains and unstained or faintly stained links alternate with deeply stained segments. This form often appears to consist of a number of short structurally similar units stained at the poles and joined end to end as mentioned under form (2). The long and more uniformly stained threads may have a similar chain-like appearance in part of their length.

(4) Darkly stained, oval, solid-looking bodies varying in size from about 1 to 1·5 micron in diameter may be seen either free or embedded in cells of the gut wall. They appear to be associated with the formation of the intracellular thread forms. They are never very numerous and may somewhat resemble rather larger bodies which are perhaps portions of nuclei and are sometimes seen in normal lice.

The staining of *R. prowazeki* with Giemsa is usually reddish or lilac but sometimes pale purple: the latter colour is more often taken on by the larger forms and threads. No doubt the differences in staining are largely due to size and also to external influences such as the character of the tissue or other material in which they lie. The staining is, however, redder and less purple as a rule than that taken up by *R. quintana* or *R. melophagi*, but decidedly less red than in the case of *R. lectularii*.

The relation of different forms and their position to the stage of infection, etc.

The very small and thread forms appear first in the cells of the stomach and gut which may only contain threads arranged in a kind of intertwining felt or basket-work around the nucleus, leaving the outer parts of the cell clear, or the threads may extend throughout the cell and even exceed the limits of a single cell and stretch continuously through two or more cells. In the later stages of infection when many gut cells are destroyed immense numbers of the smallest forms are found filling and distending the cells and also free in the lumen of the gut.

The reason for the appearance of chiefly threads in one louse and a preponderance of minute forms in another could not be definitely ascertained, but on the whole, the threads appeared to be associated with the early infections of the cells and perhaps when threads were in great numbers in late infections the explanation was that they had grown in cells which were secondarily infected from those attacked immediately after the inoculation. It seems most probable that in a louse 12 to 15 days or more after infection there would be cells in different stages of infection.

As mentioned above, deeply stained oval forms appear sometimes to precede the threads in cells, but intracellular threads may often be the first definite evidence of infection found.

The round ended rods or oval forms with deep staining at the ends and rather resembling ordinary bacteria are usually seen in small numbers at the earliest stage of infection. They appear to be free in the lumen or amongst rather than in the cells of the gut.

Ovaries: these occasionally show evidence of an apparent infection. Little importance can be attached to the presence of the minute forms unless they are very numerous because of the possibility of their escape from the gut in spite of careful dissection. The larger bacillary forms with deeply stained poles (form 2) which are present in the early stages of infection of the gut, may also be present and probably indicate that the ovaries are independently involved, since this form is not found in large numbers in the gut and is not likely to have contaminated the film from that source.

Eggs which have been dissected out of the ovaries sometimes show a considerable degree of development and may contain fairly advanced embryos probably as the result of delayed extrusion in insects kept at a temperature too low to induce laying. A few such eggs at an early stage of development

contained a large number of bacillary and thread forms, though eggs which contained advanced embryos were never found to include *Rickettsia*.

Occurrence of similar forms in different species of Rickettsia.

Whatever the ultimate position of the different species of *Rickettsia* in a system of classification and in regard to each other, there is a certain similarity amongst them in that similar varieties of form occur in at least three species.

In *R. prowazeki* and *R. lectularii* (Arkwright, Atkin and Bacot, 1921), both very minute and long thread forms occur and in *R. quintana*, short threads with six segments are sometimes seen, though rarely. In *R. prowazeki* and *R. melophagi* (Nöller, 1917 and Arkwright and Bacot, 1921) oval forms with deep polar staining are fairly common and occur at the early stages of or before cell infection and before the small forms become numerous; similar forms have also been recently observed in association with *R. lectularii*. These morphological variations are of importance because of the great difference between the extreme forms rendering recognition of the parasite under some conditions very difficult unless the range of forms in which it occurs are well known.

CONCLUSIONS.

1. *Rickettsia prowazeki* occurs in very varied forms in lice infected with typhus virus.

2. The most frequently occurring form and that seen in the greatest numbers is the minute diplococcal or rod form, 0·3 × 0·3–0·5 micron in diameter.

3. Threads 4–10 microns long and 0·3–0·5 micron in diameter are often seen in the gut cells of infected lice and much longer threads 20–50 microns, or even longer, have been seen in dissection smears. These are quite distinct and stain differently from the usually wider very long spermatozoa.

4. Forms resembling small oval or rod-shaped bacteria and stained only at the poles occur especially at an early stage of gut infection; these may also occur in chains.

5. Deeply stained oval or olive-shaped forms also occur and are probably a stage in the growth of *Rickettsia*.

6. The bipolar staining forms resembling small bacteria have been seen in the ovary and many minute and thread forms have been found in eggs dissected out of the ovary.

7. There is considerable correspondence between the range of forms in different species of *Rickettsia*, especially between *R. prowazeki*, *R. lectularii* and *R. melophagi*.

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EXPLANATION OF PLATE I.

Figs. 1 to 5 are from drawings by Miss M. Rhodes; all are ×1000. Fig. 6, by Mr J. R. Ford, is drawn on a slightly larger scale.

Fig. 1. Film of the gut of a louse of Batch 36, killed 4. xi. 21 on the seventh day after injection *per anum* with an emulsion of the gut of a louse from Batch 35.
Minute forms and long threads of *Rickettsia prowazeki*.

Fig. 2. Film of the gut of a louse of Batch 38, killed 24. xi. 21, on the thirteenth day after injection with the emulsion of a louse from Batch 36 B showing various larger forms of *R. prowazeki*, chiefly the wider threads, chains and "vacuolated" or polar staining forms resembling bacteria.

Fig. 3. From films of the guts of lice from Batch 41, examined on the tenth to the fourteenth days after injection, on 5. xii. 21, with emulsion of a louse from Batch 38. Showing an assorted collection of different forms of *R. prowazeki*.

Fig. 4. Film of the gut of a louse from Batch 40 found dead 24 hours after injection with an emulsion of a louse from Batch 37. Showing the early invasion of stomach cells with small forms of *R. prowazeki*.

Fig. 5. Film of the gut of a louse of Batch 45 found dead on 4. i. 22, the eighteenth day after injection with an emulsion of a louse from Batch 41. Showing masses of minute forms and some threads in stomach cells.

Fig. 6. Film of gut of a louse of Batch 54 injected with a platelet emulsion from a typhus guinea-pig. The louse was found dead and the emulsion made on the ninth day after inoculation. Showing cells of the gut wall infected with thread-like *R. prowazeki* forming a felt-like tangle in the cytoplasm and almost obscuring the nucleus in some of the cells.

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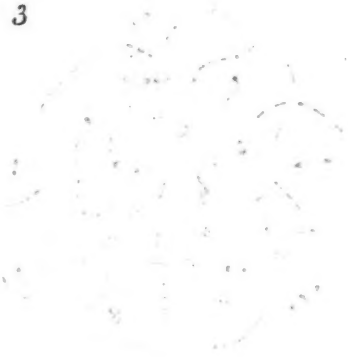

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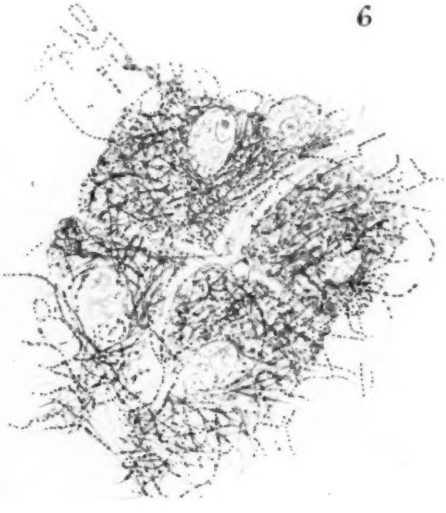

A NEMATODE (*FALCAUSTRA CHAPINI* N. SP.) PARASITIC IN A NORTH AMERICAN TORTOISE.

By C. L. BOULENGER, M.A., D.Sc.

(*From the Zoological Department, University of Birmingham.*)

(With 3 Text-figures.)

Among material recently sent for identification by the Molteno Institute of Parasitology were a number of small Nematode worms collected by Mr E. A. Chapin from the rectum of the North American Tortoise, *Cistudo carolina*.

The worms are undoubtedly to be referred to Lane's genus, *Falcaustra* (1915), of which two species, *F. falcata* (v. Linst. 1906) and *F. siamensis* Baylis, 1920, are known, both parasitic in freshwater tortoises. The form from *C. carolina* differs in a number of characters from these two species, and is here described as new under the name *F. chapini* n. sp.

The new species is of interest since it seems to form a link between Lane's genus and the genus *Florencioia* established by Travassos in 1919, with *F. mascula* (Rud.) from the snake, *Drymobius bifossatus*, as its type species.

Falcaustra chapini n. sp.

The worms are small as compared with the two known species and are slender, tapering at the two extremities. The tail is long, in both sexes gradually decreasing in breadth posteriorly and ending in a fine point.

The cuticle is very finely striated transversely, the distance between the striae being approximately 0·002 mm.

The head (Text-fig. 1) has a breadth of about 0·1 mm., in a few specimens it appears to be separated from the body by a slight constriction, in the majority, however, a "neck" is not apparent. There are three similar lips which conform in all essential characters with those described for the other species by Lane and Baylis. Each lip is broad and flattened antero-posteriorly at the margins, from the inner surface, however, it gives off a delicate, transparent, triangular plate the apex of which projects from the front of the head, a character in which *F. chapini* seems to differ from the other species. On each lip are two inconspicuous papillae with long nervous palps which give off a second branch running towards the inner margin. The head at its broadest part is supported by a cuticular ring, surrounding the oral cavity.

The oesophagus has a length of 1·3–1·5 mm., its structure being typical of the genus; the anterior division (Text-fig. 1) is longer than broad, measuring

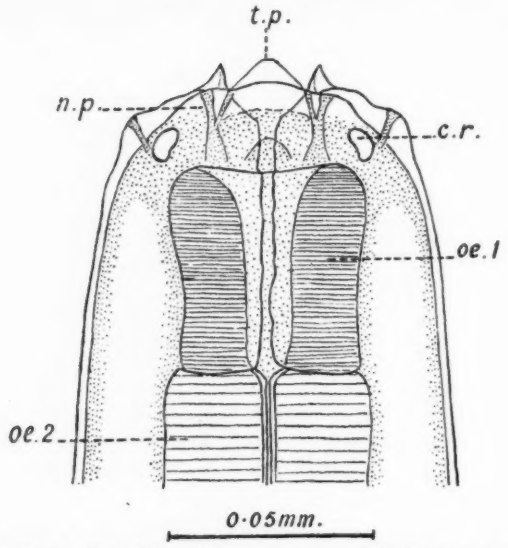

Fig. 1. *Falcaustra chapini.* Dorsal view of head-region: *c.r.*, cuticular ring; *n.p.*, nervous palp of lip papilla; *oe.* 1, anterior division of oesophagus; *oe.* 2, second division of oesophagus; *t.p.*, triangular projection of inner margin of lip.

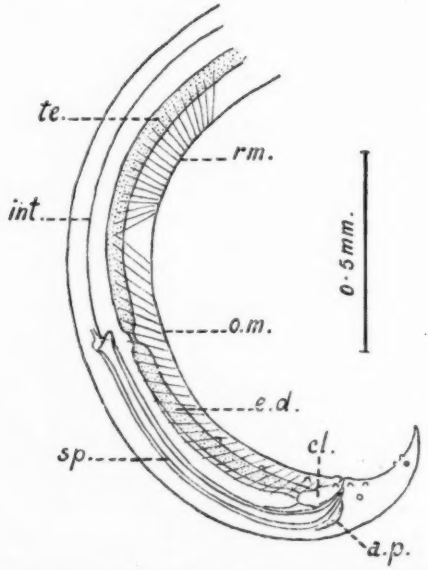

Fig. 2. *F. chapini.* Caudal region of male, lateral view: *a.p.*, accessory piece; *cl.*, cloaca; *e.d.*, ejaculatory duct; *int.*, intestine; *o.m.*, oblique muscles of caudal region; *r.m.*, radiating muscles of rudimentary sucker; *sp.*, spicule; *te.*, testis.

approximately 0·055 mm. by 0·048 mm., the oesophagus terminates posteriorly in a characteristic, hour-glass shaped, double bulb.

The nerve-ring is situated 0·3–0·35 mm. from the anterior end. A pair of very small cervical papillae can be seen 0·7 mm. from the anterior extremity, the excretory pore is about half-way between them and the level of the termination of the oesophagus.

Male. The male worms measure 5–5·7 mm. in length, with a maximum thickness of about 0·23 mm. The posterior third of the body shows a strong curvature towards the ventral side. The tail has a length of 0·28–0·3 mm. and ends in a fine point.

Anterior to the cloaca on either side is a conspicuous series of about 35–40 parallel, oblique muscle-bands, extending forwards to a point about 1·1 mm. from the posterior extremity (Text-fig. 2); immediately in front of this is another series of radiating muscles, about 20–25 in number, arranged in a precisely similar way to the group of muscles constituting the large fusiform sucker in *Florencioia mascula* or one of the smaller suckers in *Falcaustra siamensis*. In *F. chapini*, however, no trace of a sucker cavity can be seen, there is at the most a slight flattening of the ventral surface, and it seems that we are here dealing with a quite rudimentary sucker.

The arrangement of the caudal papillae is quite typical and resembles that of the known species, there are ten pairs of papillae and a median papilla, the latter situated immediately in front of the cloacal aperture, it appears to contain a double nerve-ending as in *F. siamensis*. Of the ten paired papillae two (Text-fig. 3) are more laterally situated than the rest, these are numbers 2 and 5, in this respect *F. chapini* differing slightly from the other species.

The two spicules (Text-fig. 3) are equal and similar, they are comparatively very long, measuring about 0·8 mm. in length with a maximum thickness of 0·05 mm.; as in other species each spicule is sickle-shaped and has a characteristic "double" appearance, consisting of a tubular central portion enclosed in a kind of sheath. Under high magnifications the spicules appear finely striated transversely.

The accessory piece is well developed, measuring 0·13 mm. in length, in ventral view it appears triangular or V-shaped, the apex being directed towards the cloacal opening.

Female. None of the female specimens are quite mature, the genital organs although fully developed containing no ripe ova; the largest measures 7 mm. in length with a maximum thickness of about 0·3 mm.

The caudal region is nearly straight, the ventral curvature being very slight. The tail, *i.e.* the distance from the anus to the posterior extremity, measures 0·45 mm. There seem to be no caudal papillae.

The female organs are similar to those of the two known species, the vulva is a transverse slit opening 2·3 mm. from the posterior extremity, thus dividing the body approximately as 2 : 1.

The rectum is a conspicuous feature of the caudal region, separated from the intestine by a well-developed valve it is a pyriform structure, 0·1 mm. long, lined with a rather thick refractive cuticle.

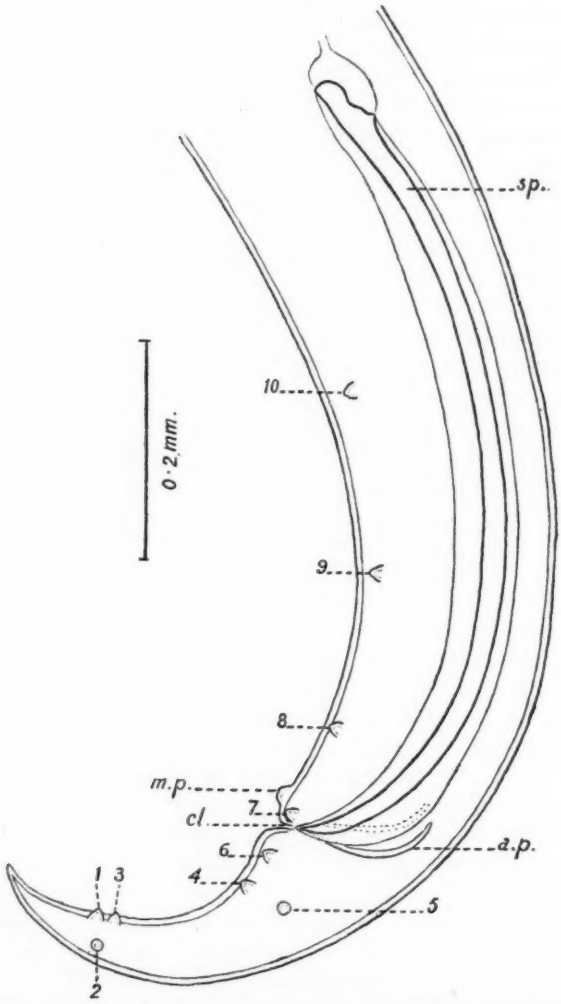

Fig. 3. *F. chapini.* Tail of male, lateral view. The paired caudal papillae are numbered 1–10; *a.p.*, accessory piece; *cl.*, cloacal aperture; *m.p.*, median preanal papilla; *sp.*, spicule.

Systematic position. There can be no doubt as to the systematic position of the new species from *Cistudo carolina*, the structure of the lips, oesophagus, male spicules and papillae agrees in every way with that of the species of

Falcaustra described by Lane and Baylis. From the known species *F. chapini* is to be distinguished by its small size, the comparatively long spicule of the male and the arrangement of the male papillae.

The presence of a rudimentary ventral sucker in *F. chapini* is a point of interest since in this character the species forms a link between the genotype *F. falcatum*, without a sucker, and *F. siamensis*, with a series of three or four suckers.

As pointed out above, *F. chapini* in this respect resembles the worm from *Drymobius bifossatus* described by Travassos under the name *Florencioia mascula* (Rud.), in fact there is nothing to distinguish the generic diagnosis of *Florencioia* given by Travassos (1920[1]) from that of *Falcaustra* as modified by Baylis (1920).

The structure of *F. chapini* emphasises the close relationship between *Falcaustra* and *Kathlania*, already noted by previous writers, and affords further justification for their inclusion in a sub-family Kathlaniinae of the Oxyuridae. In this connection I agree with Baylis (1920) that Schneider's *Oxysoma lepturum* (Rud.) (placed by Travassos in 1917 in a separate genus, *Pseudo-heterakis*) should be referred to the genus *Kathlania*, in my opinion this species is the one described by Lane (1914) as *K. kathlena* and should be re-named *K. leptura* (Rud.). Both forms were obtained from the same host, *Chelone midas*, and, although Schneider's description was incomplete, his measurements and figures agree remarkably well with those given by Lane.

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[1] In the generic diagnosis of *Florencioia* given by Travassos (1920) we find: "femeas com vulva situada na metade anterior," this is contradicted in the descriptions of the species *F. mascula* and *F. nitida*, where the vulva is said to be "situada na metade posterior"; there can be little doubt that the word 'anterior' in the generic diagnosis is due to a clerical error.

OBSERVATIONS ON THE LARVAE OF SOME DIPTERA PUPIPARA, WITH DESCRIPTION OF A NEW SPECIES OF HIPPOBOSCIDAE.

By G. F. FERRIS.

Stanford University, California.

(With 4 Text-figures.)

The available information on the larvae of the Diptera Pupipara is extremely scanty and I take this opportunity to make a small but nevertheless interesting addition to it. There are presented herewith notes on the larvae of three species, representing three of the families of the Pupipara, in one of which—the *Streblidae*—the larva of no species appears to have been described. The presentation of this information necessitates the description of a new species in the *Hippoboscidae*.

1. The larva of a Streblid, *Aspidoptera megastigma* (Speiser).

Fig. 1.

There is available a single specimen of the larva of *Aspidoptera megastigma* (Speiser), which was dissected from a female from an undetermined bat in

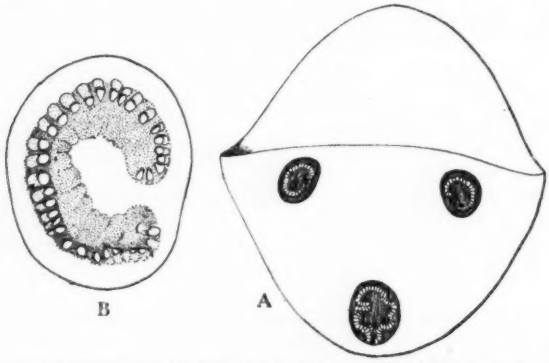


Fig. 1. *Aspidoptera megastigma* (Speiser): A, larva; B, enlargement of spiracle.

Paraguay. The specimens were received for identification through the kindness of Dr Walther Horn of the Berlin Museum.

Like the larvae of other Pupipara, this is an almost structureless sac, which, when flattened on the slide, is almost circular in outline. In this specimen

a portion of the derm, possibly representing the part that breaks away in the pupa, is broken off. The derm presents a faintly reticulate appearance. The interesting thing about the specimen is the character and disposition of the spiracles.

There are three heavily chitinized and relatively very large spiracles arranged in a triangle which occupies nearly half of one aspect of the body. The unpaired spiracle is distinctly larger than either of the others. Each spiracle (Fig. 1 B) bears a number of simple openings which are arranged in a row, forming an almost complete circle. These openings appear to communicate with an elongate chamber from which the tracheae extend. It is not possible in the specimen to trace the tracheal trunks.

The presence of an unpaired spiracle is at the least a rare thing among the insects, if it be not unique. It is possible that this spiracle is formed from the fusion of a single pair and some support is extended to this view by the fact that in the *Nycteribiidae* the members of one of the two pairs of spiracles are quite close together. The larger size of this unpaired spiracle may also be some support to this view.

2. The larva of a Nycteribiid, *Nycteribia pedicularia* (Latreille).

Fig. 2.

Among the many specimens of Nycteribiidae taken by the author from the alcoholic bats in the collection of the United States National Museum there

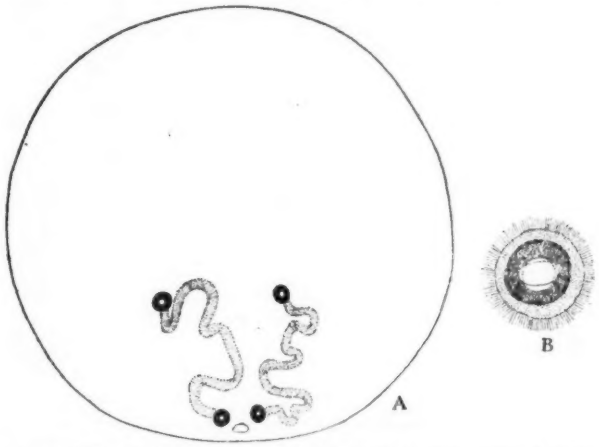


Fig. 2. *Nycteribia pedicularia* (Latreille): A, larva; B, enlargement of spiracle.

was found a single female which contained a larva. This female is a specimen of *Nycteribia pedicularia* (Lat.) from *Myotis capaccini* from Switzerland.

This larva (Fig. 2 A) agrees with the published descriptions of other Nycteribiid larvae, having two pairs of spiracles, which are situated toward the

posterior end of the body. The members of the posterior pair are much closer together than are those of the anterior pair and are set close to what appears to be the anal opening. Of the tracheae I am able to detect only a trunk connecting one member of each pair to the corresponding member of the other pair.

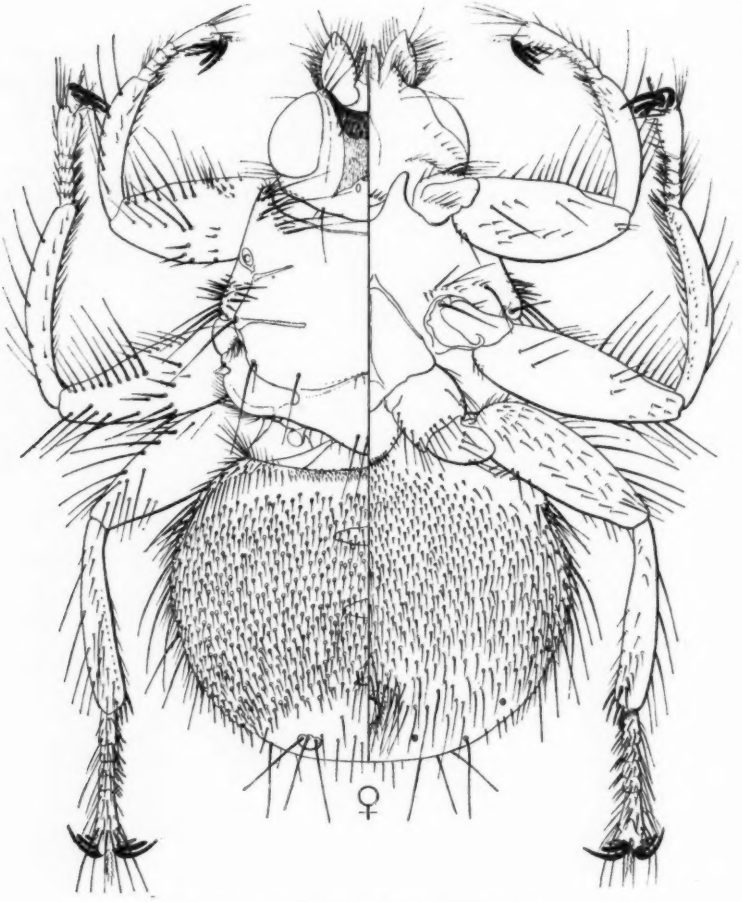


Fig. 3. *Ornithomyia strigilecula* n. sp.; female.

The spiracles themselves (Fig. 2 B) appear as a simple opening through a chamber with heavily chitinized walls. I am unable to make out the exact details and the accompanying figure represents merely the appearance of the spiracle without any special attempt to show the actual structure. The entire spiracle is surrounded by a zone of radiating lines.

3. *Ornithomyia strigilecula* n. sp.

Figs. 3 and 4.

SPECIMENS EXAMINED. A single female, from undetermined host, Lima, Peru, R. H. Beck collector, in the collection of the California Academy of Sciences.

FEMALE (Fig. 3). General colour dark brown. Length 6 mm. *Head* distinctly broader than long; dorsal side destitute of setae except for a pair at the anterior margin of the orbits and a smaller orbital pair farther back;

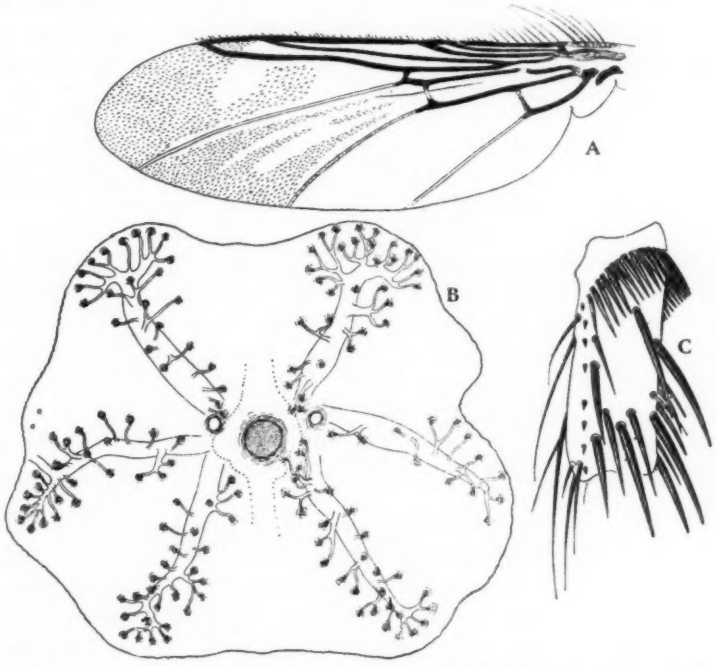


Fig. 4. *Ornithomyia strigilecula* n. sp.: A, wing; B, chitinized posterior portion of larva; C, first segment of posterior tarsus of adult.

ventral side with a row of small setae paralleling the orbits and a cluster on a prominence at each side of the palpi; antennae noticeably large, about half as long as the head, flat, tapering to a point anteriorly and bordered by many slender setae; palpi slightly shorter than the antennae, bearing numerous small setae.

Thorax with the humeral angles strongly produced and bearing several long black setae together with numerous small, stout setae; lateral margins with three or four long setae and several small, stout setae just before the wing; mesonotum destitute of setae except for one long one at the base of the wing

and two widely separated long ones behind the wing; scutellum with a few very small marginal setae and a median cluster of three quite long setae. Ventral side with no setae except for a row in front of the middle coxae; mesosternum produced anteriorly into a pair of processes which surpass the anterior coxae. Legs with no especially distinctive characters except for the presence on the first segment of the hind tarsi of a distinct comb of small, stout setae (Fig. 4 C). Wings (Fig. 4 A) of the type common to the genus, the setulae arranged in a definite pattern as shown, the posterior margin not ciliate.

Abdomen with the basal tergite very short, beset medially with many small setae, these giving way laterally to long setae; the dorsum bearing three small, median, chitinized areas and thickly beset with small slender setae except for the apical area; apical area with a pair of small chitinized areas which bear three long setae. Basal sternite small, with a marginal series of small, stout setae; remainder of the venter thickly beset with setae of which those of the median region are small and slender and those of the marginal areas and about the vaginal opening are long and slender. Spiracles quite small.

Larva. A larva dissected from this female resembles the larvae of other *Hippoboscids* in having the posterior end of the body heavily chitinized. This chitinized area (Fig. 4 B) when flattened out is roughly hexagonal in form and shows a large central opening, which is possibly the anus and appears to be closed by an internal operculum. Flanking this opening are two smaller openings of unknown homology. Radiating from the centre are six series of spiracular pores. Each of these pores communicates with a small tracheal branch which arises from a large tracheal trunk and these trunks converge toward the centre. It is not possible in this specimen to trace the relation of these trunks to each other.

Notes.—It is possible that this species is identical with some one of the various species that have been described from South America but this certainly cannot be established from the descriptions alone. Its distinctive features—as compared with *O. lagopodis* and *O. avicularia*—are especially the presence of the comb on the ventral side of the first segment of the hind tarsi and the anterior prolongations of the mesosternum.

TAPEWORM PARASITES OF DOGS IN THE PUNJAB.

By G. SONDHI, M.Sc.,

Alfred Patiala Research Scholar, University of the Punjab, Lahore.

(*From the Zoological Laboratory, University of Birmingham.*)

(With Plate II and 3 Text-figures.)

Introduction.

The parasitic worm fauna of domesticated animals in India has in the past been greatly neglected as a subject for research by zoologists working in that country. The increased interest in Helminthology during the last few years has been world-wide, and has led to greater attention being paid to Indian parasitic worms, such attention has, however, been largely devoted to the Roundworms, the Flatworms, with the exception of the Trematodes, receiving but scant attention.

The most recent list of the tapeworms infesting domesticated animals in India is that published by Gaiger (1915); this work is, however, largely a compilation and the species included are greatly in need of revision in the light of recent systematic work in Europe and America.

Whilst in Lahore last year, Dr Boulenger suggested that I should undertake an investigation of the Cestode parasites of dogs in the Punjab; the numerous tapeworms infesting this host have in the past been subject to much confusion, and it is only during the last few years that, chiefly owing to the careful researches of Hall and Ransom in the United States, our knowledge of this section of the Entozoa has been placed on a satisfactory basis. Outside America a revision of the dog tapeworms has not been attempted and even in England our knowledge of this subject is by no means satisfactory[1].

The observations recorded in the present paper were commenced in Lahore, where a collection of worm parasites from dogs in and around the city was undertaken; the difficulties in carrying on the work of identifying these forms without access to an extensive literature and without comparison of specimens from other sources were found insuperable, and it was decided to continue the research in England, where admission was gained to the Zoological Department of the University of Birmingham, under Prof. F. W. Gamble, F.R.S., to whom

[1] As an example it may be mentioned that during my examination of some material from dogs collected in the Birmingham and Leeds districts, some of the specimens generally regarded as the common *Dipylidium caninum* proved to be examples of *D. sexcoronatum* von Ràtz, a species not previously recorded from this country.

I wish to express my gratitude for his unfailing assistance and advice throughout the course of the investigation. I also wish to thank Dr C. L. Boulenger and Dr F. J. Meggitt for much advice and friendly criticism during the preparation of this paper.

The material examined by me was collected entirely from pariah dogs in Lahore, lack of time and opportunity preventing similar attention being paid to dogs from country districts. The pariah dogs in India wander about the streets and are nobody's property; they have easy access to slaughter-house and other offal which is usually thrown in the streets. An important fact which must be taken into consideration is that cattle, sheep and goats in a large town like Lahore are every morning driven out into the pastures adjoining the town, on their way through the streets picking up whatever rubbish they can get; any proglottides of worms passed by dogs are likely to be picked up in this way, thus, obviously, increasing the chances of propagation of such forms of tapeworms as *Taenia hydatigena*, *Multiceps multiceps*, etc.

Speaking generally, the dogs examined were for the most part quite healthy, the presence of parasites having no marked effect. Apparently healthy dogs were found to harbour hundreds of tapeworms and only in one case did these seem the cause of death, a tangle of a large number of the parasites evidently obstructing the intestine.

I wish to take this opportunity of thanking Colonel G. K. Walker, C.I.E., Principal of the Punjab Veterinary College, for permission to carry out the various dissections in his laboratories and for the loan of a number of specimens of tapeworms from the College collections; my thanks are also due to Dr Arora, Public Health Officer, Lahore, for his assistance in obtaining carcases of pariah dogs.

For various reasons it was found most convenient to fix the tapeworms in 10 per cent. formalin, the specimens being then preserved in a 5 per cent. solution of the same liquid and eventually transferred to 70 per cent. alcohol. For general purposes the formalin fixative was found to be quite satisfactory, and very good results with whole mounts were obtained from material fixed in this way and stained with acid alum carmine.

In all, nine species of tapeworms were obtained from the material collected in Lahore, these being distributed among four genera, as shown in the list given below:

1. *Dipylidium walkeri* n. sp.
2. „ *sexcoronatum* von Ràtz, 1900.
3. „ *oerleyi* von Ràtz, 1900.
4. *Multiceps multiceps* (Leske, 1780).
5. „ *gaigeri* Hall, 1916.
6. „ *serialis* (Gervais, 1847).
7. *Taenia hydatigena* Pallas, 1766.
8. „ *ovis* (Cobbold, 1869).
9. *Echinococcus granulosus* (Batsch, 1786).

Of these, examples of *Dipylidium* proved to be by far the most abundant, more than 65 per cent. of the tapeworms collected being referred to this genus.

Genus **DIPYLIDIUM** Leuckart, 1863.

Contrary to expectations the type-species, *Dipylidium caninum* (L.), was not met with in the material from Lahore, it seems certain that the form recorded by Gaiger (1915) and other authors under this name as occurring in dogs in Northern India must belong to one of the other species of the genus.

The species found to be the most abundant in the Lahore dogs failed to agree in many characters of importance with any known form and is here described as new.

Dipylidium Walkeri n. sp. (Plate II, figs. 4–5.)

The head (Fig. 4) is small, measuring 263–361 μ in diameter with the rostellum invaginated, but only 185 μ in one specimen in which the rostellum was evaginated. The shape of the scolex depends on the amount of contraction it has undergone, speaking generally it has the shape of a blunt cone and is broader than long, but becomes longer than broad when the rostellum is evaginated.

The rostellum is elongated and wedged in between the suckers at its widest part a little behind the anterior end, measures 63–100 μ in diameter. There are 6–7 alternating circlets of rose-thorn shaped hooks, the first circle of hooks commencing a little behind the anterior end of the rostellum. The hooks gradually decrease in size from before backwards, those of the first row may be as long as 12 μ and those of the last row as small as 2 μ. The four suckers are circular in outline, with a diameter varying from 118–150 μ. A short neck is present.

As a rule the strobilus is thinner than that of *D. sexcoronatum* or *D. caninum*, and varies in length between 10–28 cm. The mature segments are at least three times as long as broad, gravid ones measuring about 4·5–·8 cm. long and 1·5–2·5 mm. broad.

In the anterior part of the strobilius both dorsal and ventral excretory vessels are present on each side, but in and posterior to the mature segments only the ventral ones can be seen. The genital pores are situated in a deep conical depression a little anterior to the centre of the lateral margin in the immature segments, and about the centre or slightly posterior to it in the mature and gravid proglottids.

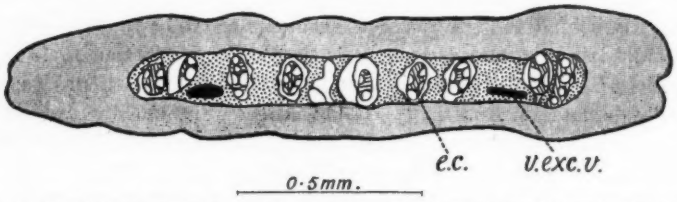
Male genitalia. There are approximately 225 ovoid testes in each mature segment, generally they are confined to the area between the lateral excretory vessels, but not infrequently extend beyond them; they are absent from a clear area in the anterior part of each segment. There are comparatively few testes between the female genital organs, the number varying from 10 to 15, dorso-ventrally the testes lie in a single layer. Each testis measures approximately 72–90 $\mu \times$ 54–59 μ. The vas deferens is much coiled and extends

anteriorly to the cirrus pouch, with its coils dorsal to the ventral excretory canal. The cirrus measures about 45–54 μ long and 14–21 μ wide, the cirrus pouch may or may not extend as far as the lateral excretory trunk.

Female genitalia. The ovaries are diffuse structures beginning about the level of the genital pores and extending posteriorly to the vitellarium, each is divided into an outer smaller and an inner larger lobe by the course of the vagina. The larger lobe commences just posterior to the vas deferens, its inner border is convex and its outer parallel to the vagina; the smaller lobe lies obliquely, posterior to the larger lobe, its outer border is convex and its inner parallel to the vagina. Dorso-ventrally the ovaries occupy the entire thickness of the medullary parenchyma, they are connected by a ventral isthmus.

The vitellarium has the appearance of a bunch of grapes and lies immediately posterior to and in contact with the ovary, being generally larger than the outer lobe of the latter. The shell-gland is a fairly large structure, lying partly in a groove on the dorsal surface of the anterior part of the vitellarium, and partly anterior to it.

The uterus sends out lateral branches which form a network in the meshes of which lie the testes; it has definite walls, and its branches first appear in the lateral fields of the segment, invading the median field later. The egg capsules



Text-fig. 1. *Dipylidium walkeri* n. sp. Transverse section through gravid proglottis: *e.c.*, egg-capsule; *v. exc. v.*, ventral excretory vessel.

contain 1–15 eggs, they are not very tightly packed together and extend beyond the lateral excretory vessels, there is a clear area anteriorly and a much smaller one posteriorly, dorsoventrally they lie in a single layer. The eggs measure approximately 35 μ in diameter, the shell about 4 μ thick.

The following table distinguishes this species from all others containing more than one egg in each egg-capsule. In my opinion, the differences are sufficient to justify the creation of a new species which I have much pleasure in naming *Dipylidium walkeri*, after Lieut.-Colonel G. K. Walker, C.I.E., Principal of the Punjab Veterinary College, Lahore.

Species	No. of circlets of hooks	Position of genital pore	Length of cirrus pouch	Distribution of testes
D. caninum	3–4	Middle or posterior to the middle of the lateral margin	Extends to the lateral excretory vessel	100–200 between the lateral excretory vessels
D. dongolense	4	Not far from the anterior boundary of the segment	—	Between and posterior to the ovaries
D. ōerleyi	5	Posterior to the middle of the lateral margin	Crosses the lateral excretory vessel	90–100. Fill the anterior and posterior field between the lateral excretory vessels
D. sexcoronatum	6	Posterior to the middle of the lateral margin	Extends to the lateral excretory vessel	130–140 between the lateral excretory vessels
D. walkeri n. sp.	6–7	Middle of the lateral margin	Extends to the lateral excretory vessel	More than 200 mainly confined between the lateral excretory vessels, but some extend beyond them

Species	Shape of vitellarium	Distribution of egg-capsules	No. of eggs in an egg-capsule	Primary host
D. caninum	Irregular	Tightly packed, extending beyond the lateral excretory vessels	5–20	*Canis familiaris* *C. mesomelas* *Felis catus* *F. maniculata* *Homo sapiens*
D. dongolense	—	Extend into the cortical layer	Several	*Genetta dongolana*
D. ōerleyi	Irregular	Not very tightly packed, extending beyond the lateral excretory vessels. Dorsoventrally in a single layer	Eggs lie in groups in the egg-capsules	*Felis domestica* *Canis familiaris*
D. sexcoronatum	Reniform	Tightly packed, extending beyond the lateral excretory vessels and do not lie in a single layer dorsoventrally	2–15	*Canis familiaris*
D. walkeri n. sp.	Like a bunch of grapes	Not tightly packed, and lie in a single layer dorsoventrally	1–15	*Canis familiaris*

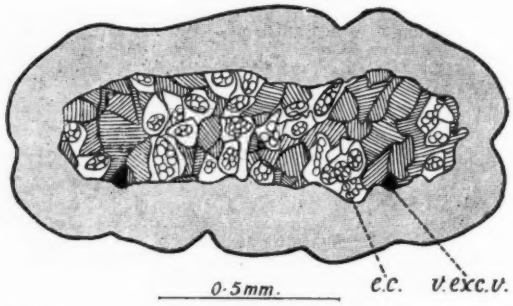
Dipylidium sexcoronatum von Ràtz, 1900.

The general anatomy of this species agrees with Hall's description (1919, 65). In contrast to him, in my specimens there were more than 200 spherical testes (Hall mentions 130–140) filling the entire area between the lateral excretory vessels not occupied by the other genital organs, and only leaving vacant a narrow band anteriorly; dorsoventrally they lie in a single layer. The egg-capsules first make their appearance along both sides of the lateral excretory vessels, both anteriorly and posteriorly to the genital pore; except for a small space in the anterior part of the proglottis they fill the entire segment, being particularly numerous in the posterior and lateral fields external to the excretory vessels and extending almost to the lateral margin; along the lateral

excretory vessels they are arranged generally with their longitudinal axes transverse to the segments and dorsoventrally they are more than one layer in thickness.

This is the first record of *D. sexcoronatum* from Asia, it being previously known only from the United States and Hungary.

The species is fairly common, and in order of frequency comes next to *D. walkeri*, 35 per cent. of the specimens examined belonging to this species.

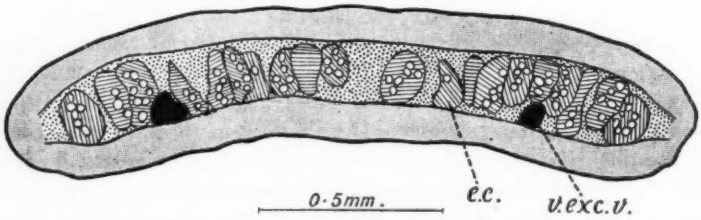


Text-fig. 2. *Dipylidium sexcoronatum* Ràtz. Transverse section through gravid proglottis: *e.c.*, egg-capsule; *v. exc. v.*, ventral excretory vessel.

Dipylidium öerleyi von Ràtz, 1900.

The form from the dog seems to be slightly larger than that from the cat, measuring from 9·5 cm. to 21·5 cm. in length. (Hall's measurements are 5–11 cm.)

The species is recorded here for the first time from the dog, the form being so far known only as a parasite of the cat; this is also the first record of the species from the Asiatic continent.



Text-fig. 3. *Dipylidium öerleyi* Ràtz. Transverse section through gravid proglottis: *e.c.*, egg-capsule; *v. exc. v.*, ventral excretory vessel.

The form is less abundant than the other two species; its frequency being only 25 per cent. of the worms referred to the genus *Dipylidium*.

Genus **MULTICEPS.**

Multiceps multiceps (Leske, 1780). (Plate II, fig. 2.)

In contrast to Hall's experience (1919, 47) the primordia of the genital organs make their first appearance quite early as small dots in the centre of the 25th proglottis, the ducts appearing first and the genital pore, testes and ovaries being formed much later. The primordia make their first appearance as darkly staining patches in the centre of the 20th to 25th segments, later they become Y-shaped structures, the long limb lying across the segment, the anterior short limb represents the vas deferens and the posterior the vagina, while the stem of the Y is formed by the portions of the ducts running out to the genital pore; posteriorly as the proglottids increase in length, the short limbs of the Y open out, the median stem of the uterus appearing at the same time so that the whole has the appearance of a T. There are also from 120–150 testes (Hall, 200). The vitellarium has a beaded appearance and is triangular in outline, with the base resting upon the transverse excretory canal (in Hall's figure it is shown more anteriorly). The vagina during its course between the ovaries in about 50 per cent. of the segments crosses the uterus.

The rest of the anatomy agrees with Hall's description.

Multiceps gaigeri Hall, 1916. (Plate II, fig. 1.)

In a mature segment there are approximately 160 testes (Hall 200–225) mostly lateral and lying closely packed along the excretory canals. In each segment there is a clear area anteriorly from which the testes are absent: posterior to this they extend into the median field, overlapping the uterus, but even then are much more abundant laterally than medianly. There is a clear space, not so large as in *M. multiceps*, in front of the ovaries. The vitellarium is triangular in shape with the shell gland at its apex and its base touching the transverse excretory canal (in Hall's diagram (1919, Fig. 49) of a mature segment it is shown lying well in front of the transverse excretory vessels), in post-mature segments it may lose its characteristic shape and is then generally drawn out longitudinally. In other respects the anatomy agrees with that described by Hall.

Mutticeps serialis (Gervais, 1847).

Gaiger (1907) and Southwell (1912) recorded this species from India. Hall, however (1919), pointed out that, owing to the absence of rabbits from India, the forms referred to this species must have been specimens belonging to one hitherto unknown and which he named *M. gaigeri*. *M. gaigeri* and *M. serialis* differ so much from one another that it is not possible to mistake one for the other. I feel certain that *M. serialis* is not uncommon in India along with *M. multiceps* and *M. gaigeri*. The question of the possible intermediate host, however, must be left for further investigation, though the prevalence of the wild hare I think indicates the possibility of its being the intermediate host.

Genus **TAENIA.**

Taenia hydatigena Pallas, 1766. (Plate II, fig. 1.)

In their general anatomy my specimens agree with the description given by Hall (1919, 28) except that the clear area shown around the ovaries in Hall's figure (Fig. 35) could not be seen in my preparations, on the contrary, in these the testes extend inward dorsally to the outer borders of the ovaries, also between the ovaries and the vitellarium: a few also are usually present dorsal to the latter.

This species is fairly common in India.

Taenia ovis (Cobbold, 1869).

This species was found on one occasion only. This is the first record of *T. ovis* from the Asiatic continent, it being previously known from Europe, America, Africa and New Zealand.

Genus **ECHINOCOCCUS.**

Echinococcus granulosus (Batsch, 1785).

This well-known species is of occasional occurrence in pariah dogs. The specimens observed by me were all obtained from one individual.

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EXPLANATION OF PLATE II.

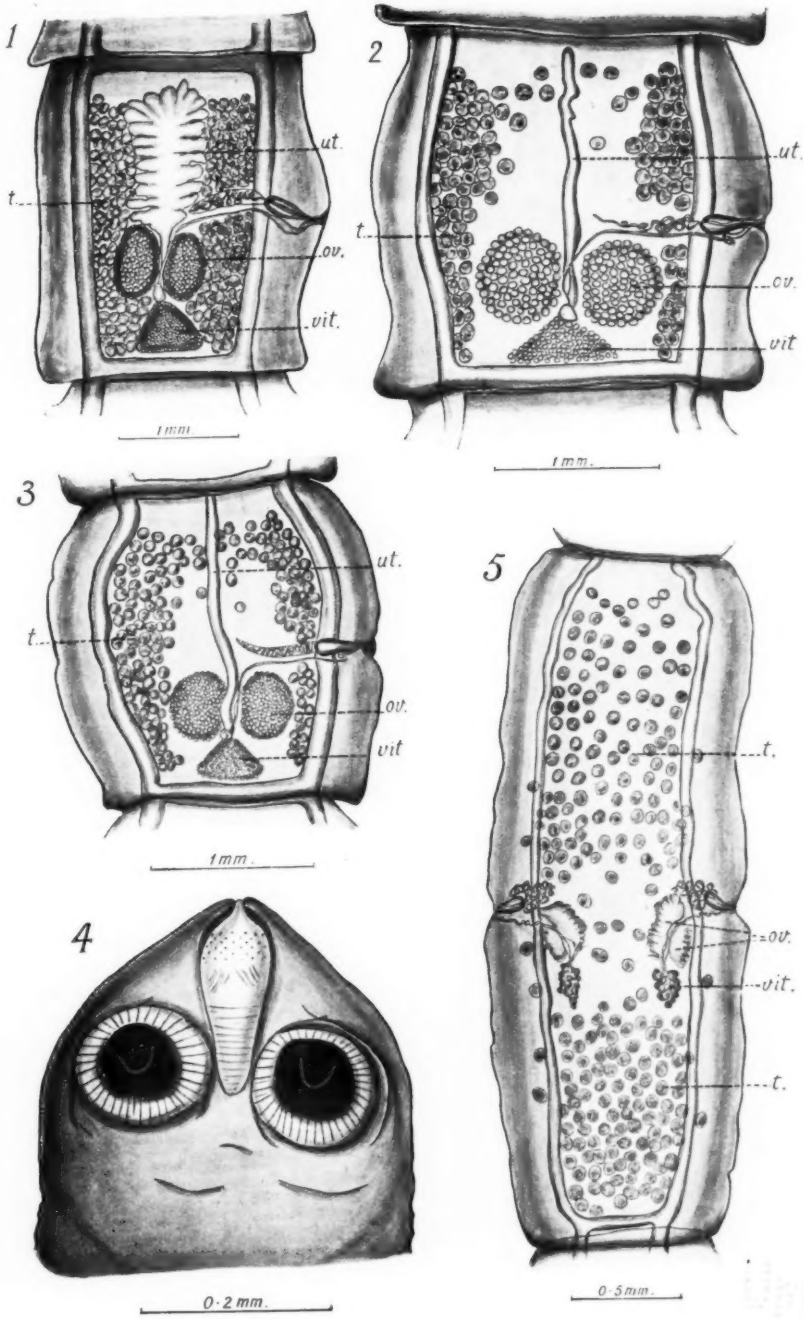
The following letters apply to all the figures: *ov.*, ovary; *t.*, testes; *ut.*, uterus; *vit.*, vitelline gland.

Fig. 1. *Taenia hydatigena* Pallas. Mature proglottis.

Fig. 2. *Multiceps multiceps* (Leske). Mature proglottis.

Fig. 3. *Multiceps gaigeri* (Hall). Mature proglottis.

Figs. 4–5. *Dipylidium walkeri* n. sp. Fig. 4. Scolex. Fig. 5. Mature proglottis.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NOTE ON THE GENUS *DIAPHANOCEPHALUS* (NEMATODA: STRONGYLIDAE), PARASITIC IN REPTILES, WITH A DESCRIPTION OF THREE NEW SPECIES.

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(With Plate III and 4 Text-figures.)

The genus *Diaphanocephalus* was erected by Diesing in 1851 to contain certain species included in Rudolphi's *Synopsis* in the old genus *Strongylus*. The species in question were *Strongylus galeatus* Rud., 1819, re-named *Diaphanocephalus strongyloides* by Diesing, and subsequently indicated as the type-species of the genus; *S. costatus*; and possible *S. viperae* Rud., which Diesing listed as a *species inquirenda*. In deciding upon the necessity for the new genus Diesing seems to have been influenced largely by the characters of the head. His diagnosis shows that he considered the supporting rays of the buccal capsule to be four only in number, regarding two of these as divided each into two distinct processes. Molin (1861) gave an emended diagnosis of Diesing's genus and proposed the new genus *Kalicephalus* for certain other strongyle parasites in reptiles. It has already been pointed out (Baylis and Daubney) that the generic characters used by Molin are unreliable and that Railliet and Henry (1909) were justified in abolishing *Kalicephalus* in favour of the older genus, *Diaphanocephalus*. Recently, Skrjabin (1916) has given a diagnosis of the genus. Through the kindness of Dr H. A. Baylis the writer has been able to examine specimens in the collection of the British Museum (Natural History), and the Wellcome Bureau of Scientific Research. The material examined includes four specimens of the genus *Diaphanocephalus*.

Generic Diagnosis. Strongylidae with head laterally compressed, and mouth having the form of a dorsoventral slit. Six oral papillae. Buccal capsule large, its lateral walls valve-like, carrying each three parenchymatous processes or bands springing from inside a basal collar and ending in the six oral papillae. Dorsal and ventral portions of buccal capsule wall considerably thickened towards base. Duct of dorsal oesophageal gland projecting into buccal cavity. Head truncate; its anterior surface inclining more or less towards the dorsal side. Externally the border of the mouth may bear a rudimentary leaf crown, while internally its orifice is guarded by a diaphragm-like membranous disc. Body cylindrical and noticeably tapered posteriorly. Dorsal ray

of bursa in male divides into two branches below the point at which the external dorsal ray is given off. The inner of these branches (*i.e.* the one nearer the median line) is again divided near its tip. Spicules equal and alate. Accessory piece present or absent. Vulva situated in posterior half of body. Uteri divergent. Eggs oval, thin-shelled, unsegmented when deposed.

Type-species. *Diaphanocephalus galeatus* (Rud. 1819) from *Podinema teguexin*.

Railliet (1916) has proposed a sub-family, *Deletrocephalinae*.

It seems probable that a revision of the genera concerned would justify the inclusion in this subfamily of *Deletrocephalus* Dies., 1851, *Diaphanocephalus* Dies., 1851, and *Globocephalus* Molin, 1861.

Diaphanocephalus willeyi (v. Linstow, 1904).

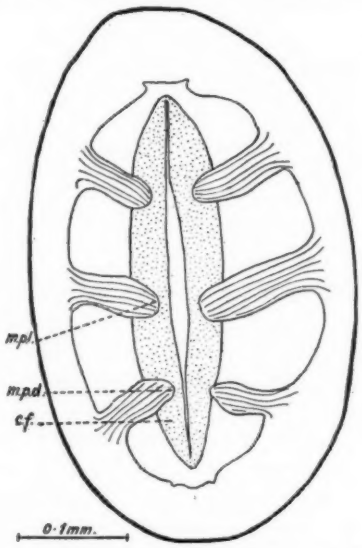
(Text-fig. 1 and Plate III, figs. 1 and 2.)

This species was originally described by v. Linstow (1904) from *Coluber helena* and *Vipera russellii*, and has since been recorded by the same author (1906) from *Typhlops braminus* and (1908) from *Bungarus fasciatus*. From the last named host it has also been recorded by Baylis and Daubney (1922).

The male measures from 10·5 to 11·5 mm. and up to 0·35 mm. in thickness; the female from 15 to 17 mm. and up to 0·5 mm. respectively. The body is tapered posteriorly while the head is broad laterally and abruptly truncate. The head is not tilted, and the mouth opening faces directly forwards. The head of the female measures about 0·45 mm. in dorsoventral diameter, and the buccal capsule about 0·23 mm. in depth. The mouth opening is guarded by an extremely rudimentary *corona radiata*, of which the individual elements are small and poorly formed. The base of the head is surrounded by the usual parenchymatous collar from which spring the three pairs of processes. These processes run forward to terminate in the circumoral papillae, four sub-median and two lateral. Viewed *en face* the mouth is seen to be limited by a curtain-like, elliptical cuticular flap which gives it the form of a dorsoventral slit. The dorsal and ventral angles of the cuticular flap are turned back some little distance along the dorsal and ventral surfaces of the buccal capsule walls (Text-fig. 1).

The wall of the buccal capsule is remarkably stout dorsally and ventrally. Posteriorly there are dorsal and ventral median prolongations which are directed backwards and outwards at an angle of about 45° from the main axis of the worm. These processes give attachment to elliptical muscle fibres which encircle the oesophagus. Contraction of these fibres would appear to close the mouth opening by lengthening its dorsoventral axis, thus pulling the edges into apposition, while relaxation would allow the mouth to open. It is also a peculiarity of this species that the chitinised portion of the buccal capsule wall extends some distance along the floor of the buccal capsule dorsally and ventrally, giving it a curious Y-shaped appearance in optical section (Plate III, fig. 1). The duct of the dorsal oesophageal gland is short, projecting 0·085 mm.

into the lumen of the buccal capsule—less than half its depth. The oesophagus is 0·87–1·1 mm. long and up to 0·3 mm. in thickness. It is short, thick, and like the Etruscan vase to which Molin compared it. A sharp constriction marks the site of the nerve-ring at about 0·24 mm. from its anterior end. At about the same level the position of the excretory pore is noticeable by reason of a pronounced indentation of the cuticle. The cervical papillae are sessile and inconspicuous. They are situated at a little more than half-way along the oesophagus, at about the level of the commencement of the bulb-like swelling. The oesophageal valves are plainly seen. No intestinal diverticula can be made out, but that portion of the intestine immediately behind the oesophagus



Text-fig. 1. *Diaphanocephalus willeyi*. Head (*en face*). For lettering see p. 74.

usually contains a mass of darkly pigmented material probably derived from blood. (Erythrocytes and fragments of mucous membrane are occasionally observed in the buccal capsule.)

Female. *Anus* opens at about 0·37 mm. from the tip of the tail, which is acutely conical. *Vulva* in posterior half of body, dividing latter in proportion of about 10·5 : 5. Lips of vulva prominent, anterior one especially so, nothing in nature of papilliform outgrowth. Short transverse vagina opening into well-developed muscular ovejectors. In specimens examined the anterior uterus extends to within from 3 to 3·5 mm. of base of oesophagus, and the posterior almost to level of anus. *Eggs* measure from 0·055 to 0·07 mm. in length and from 0·035 to 0·045 mm. in breadth.

Male. *Genital bursa.* Dorsal ray is stout and fairly long. Externo-dorsal rays stout and short leaving main trunk of dorsal ray high up. Main dorsal

trunk next divides into two branches of which inner is bifurcate at its tip. Lateral rays about equal in length and thickness. Ventro-lateral ray somewhat shorter and blunter than the other two lateral rays and rather divergent from the medio-lateral. Latter and postero-lateral closely applied to each other. Ventral rays, long, slender, closely applied to each other throughout their length.

Spicules, slender, equal, faintly alate, and slightly twisted spirally near tip, 0·435 mm. long and up to 0·022 mm. thick. Axis comparatively dense in structure, alae membranous, transparent, faintly striated transversely, and slightly expanded at tip. No accessory piece, but dorsal wall of canal in which spicules slide is imperfectly chitinised. Chitinised portion is straw-yellow in colour and roughly shape of letter Y, the two branches being directed anteriorly. This partial chitinisation is a feature of two species that have been examined. *Genital cone* rather large, about 0·1 mm. long and about 0·13 mm. in maximum thickness, its free border ornamented by folds of cuticle.

This species has been re-described on account of its close resemblance to the next species, *Diaphanocephalus simus*, the original description is obscure on certain points, which are of importance in differentiating the two.

Diaphanocephalus simus sp. nov.

(Text-fig. 2 and Plate III, figs. 3 and 4.)

This species is described from two lots of material in the collection of the British Museum (Natural History) and material (two batches) from the Wellcome Bureau of Scientific Research. In every case the host is the spitting cobra, *Naja nigricollis*, and the locality Africa. The species is a medium-sized, rather robust one, the males measuring from 9 to 11 mm. in length and up to 0·41 mm. in thickness; the females from 14 to 17 mm. and up to 0·68 mm. respectively. The body is tapered posteriorly, while the head is large, up to 0·52 mm. (female specimen) in dorsoventral diameter, and laterally compressed. The anterior end is obliquely truncate. This has the effect of making the buccal capsule shallower dorsally than ventrally, and tilting the mouth opening towards the dorsal surface. The buccal capsule is about 0·24 mm. deep at its centre. There is a small triangular process externally on the median of the three lateral parenchymatous bands at about the point where it emerges from the basal collar. The dorsal gutter projects into the lumen of the buccal capsule for a distance of about 0·16 mm., that is, about two-thirds of its depth. The oesophagus is of the usual shape and measures 0·7 mm. in length. The excretory pore and nerve-ring are situated at about 0·05 mm. from the anterior end. The former is marked by a very noticeable depression in the cuticle, as in the case of *D. willeyi*.

Female. *Anus* about 0·45 mm. from tip of tail which is acutely conical. *Vulva* divides body in proportion 12 : 5. Its form is variable, but usually lips are enlarged to form a "papilla." Not uncommonly lips form a raised cuticular ring, surrounding small depression, on floor of which the vulvar opening is found. Ovejectors muscular. Anterior uterus extends to within 3·0 mm. of

base of oesophagus, posterior to within 0·5 mm. of the anus. *Eggs* measure 0·054–0·068 mm. × 0·036–0·043 mm.

Male. *Genital bursa* and *spicules* indistinguishable from those of *D. willeyi*. Canoe-shaped *accessory piece* 0·21 mm. long, pale yellow in colour, and apparently imperfectly chitinised. *Genital cone* a little larger but similar in shape to that of *D. willeyi*, with similarly ornate border, 0·14–0·18 mm. long and 0·18–0·22 mm. in maximum breadth.

This species closely approaches *D. willeyi*, but certain characters afford a comparatively easy means of distinguishing the two. The more important of these specific characters are (*a*) the presence or absence of the chitinised Y-shaped prolongations of the wall of the buccal capsule, (*b*) the distance for which the dorsal gutter projects into the lumen of the buccal capsule, (*c*) the tilting of the mouth opening towards the dorsal side in the one species, and (*d*) the presence or absence of a true, freely moving, accessory piece in the male.

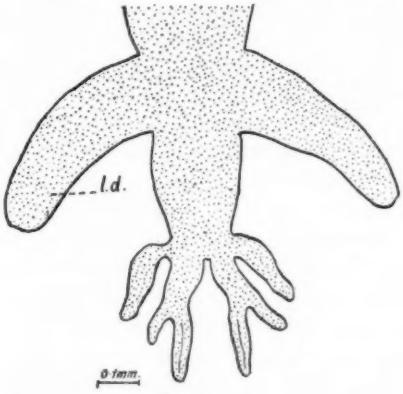


Fig. 2.

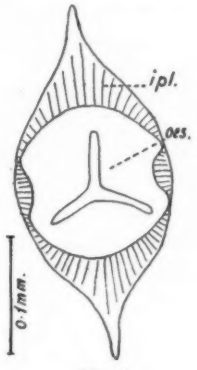


Fig. 3.

Text-fig. 2. *D. simus*. Dorsal ray of bursa.
Text-fig. 3. *D. obliquus*. Interior of mouth cavity (transverse section).
For lettering see p. 74.

Diaphanocephalus obliquus sp. nov.

(Text-fig. 3, Plate III, figs. 5 and 6.)

This species occurs three times in the collection of the British Museum (Natural History). In one case the host is *Bitis arietans*, in another *B. gabonica*, and in a third case *Causus rhombestus*. All the material is from Africa. It is about the same size as the two preceding species, but is if anything a little more slender. The males measure from 7 mm. to 9 mm. in length and up to 0·3 mm. in thickness; the females from 11 mm. to 13 mm. and up to 0·42 mm. respectively. The head is smaller, measuring about 0·25 mm. (female specimens) in dorsoventral diameter. It is noticeably different in shape, tapering anteriorly. Its anterior surface is definitely rounded and has a very pronounced tilt towards the dorsal side. The buccal capsule is about 0·175 mm. deep at

its centre. The obliquity of the anterior surface of the head has the effect of shortening the dorsal wall of the capsule to a height of about 0·13 mm. With the worm in the dorsoventral position the duct of the dorsal oesophageal gland appears to project into the buccal capsule for a distance of about 0·09 mm. or about half its depth at the centre. Actually the opening of the duct is not far below the level of the mouth opening on the dorsal side (Plate III, fig. 6). There is a small, flattened process with a rounded anterior edge on the median parenchymatous band of the buccal capsule. The oesophagus is about 0·60 mm. long, and of the usual shape. The valves may be plainly seen. The nerve-ring is situated at about 0·17 mm. from the anterior end of the oesophagus. The opening of the excretory duct is just behind the level of the nerve-ring. In contrast to the case in the two preceding species the pore itself is inconspicuous and its site is not marked by any indentation of the cuticle; in fact it is rather difficult to make out.

Female. *Anus* about 0·31 to 0·33 mm. from tip of tail, which is drawn out into a rather long, acute point. *Vulva* is situated 4 mm. from posterior end in female 11 mm. long. Lips of vulva modified into prominent papilliform outgrowth, with actual opening at summit of papilla or a little anterior to it. Coils of posterior uterus extend almost to level of anus, while those of anterior one reach to within about 3 mm. from base of oesophagus. *Eggs* 0·055 to 0·07 mm. in length, and 0·035 to 0·045 mm. in breadth.

Male. *Genital bursa* without specific characters. *Genital cone* rather small, about 0·07 mm. in length and 0·09 mm. in maximum thickness, with free border almost plain. *Spicules* long, slender, faintly alate, about 0·04 mm. long, tapering from base (maximum width *ca.* 0·014 mm.) to a very fine point. *Alae* clear, membranous, extending to tip of spicule which is sharply bent almost to a right angle about 0·015 mm. from the tip. *Accessory piece* pale, straw-coloured, about 0·15 mm. long, in the form of a slender rod tapering from its anterior end, which bears a dorsally directed spur, a similar but rather smaller dorsally projecting spur at posterior extremity.

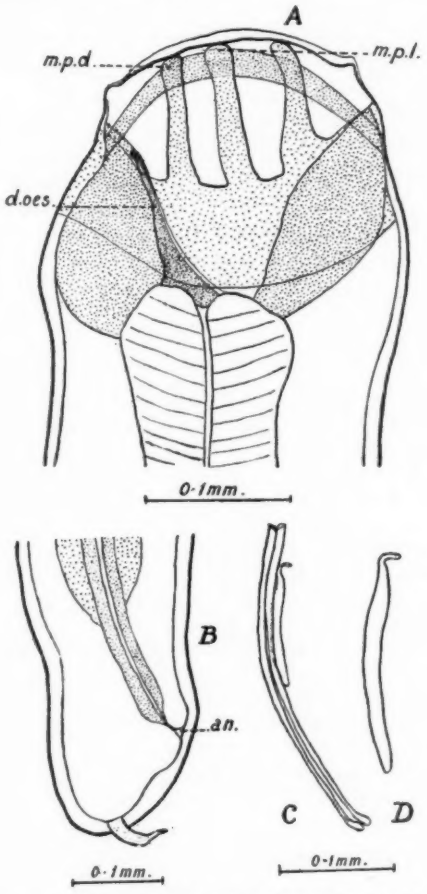
Diaphanocephalus micrurus sp. nov.

(Text-fig. 4 *A*, *B*, *C* and *D*.)

Host: *Macrelaps microlepidotus*. Locality, Pietermaritzburg, Natal. This is a slender species of medium length.

The males measure from 7·5 to 8 mm. in length, and up to 0·25 mm. in thickness; the females from 11·5 to 12·5 mm. and up to 0·4 mm. respectively. The head may be regarded as intermediate in shape between that of *D. simus* and that of *D. obliquus*, *i.e.* though somewhat rounded in outline it is not so freely curved as in the case of the latter species, nor is the tilting of the mouth opening towards the dorsal side so marked. The head measures 0·27 mm. in diameter in the female specimens. The buccal capsule is about 0·16 mm. deep at its centre. The duct of the dorsal oesophageal gland projects for a distance

of about 0·09 mm. into the lumen of the buccal capsule, rather more than half its depth when viewed dorsoventrally. The duct actually reaches to within a short distance of the dorsal angle of the mouth (Text-fig. 4 *A*). The oesophagus is of the usual shape and measures from about 0·29 to 0·32 mm. in length. At the thickest part of the bulb it is about 0·17 mm. in diameter. The



Text-fig. 4. *D. micrurus*. *A*, head (lateral); *B*, tail of female (lateral); *C*, spicules and accessory piece of male; *D*, accessory piece of male. For lettering see p. 74.

nerve-ring is situated at about 0·27 mm. from the anterior end. The opening of the excretory duct, which is extremely inconspicuous, is at about the same level.

Female. *Anus* 0·09 to 0·11 mm. from posterior extremity. The tail is not conical in shape, but only slightly tapered and rounded off, carrying a small,

pointed process at its tip (Text-fig. 4 *B*). *Vulva* about 8 mm. from anterior end in a female 12 mm. long, remarkably variable in form. In some specimens lips are modified into a papilliform outgrowth which projects backwards at an angle of about 45°, the actual vulvar opening being at summit of papilla. In others vulva is a slightly prominent transverse slit, opening on floor of a depression formed by two swellings, one anterior and one posterior to actual opening. The coils of posterior uterus reach to within about 0·48 mm. from base of oesophagus. *Eggs* 0·055 to 0·058 mm. in length and 0·038 to 0·04 mm. in breadth.

Male. *Genital bursa* without specific characters. *Genital cone* about 0·1 mm. in length and maximum thickness with free border apparently inornate and lateral borders ill-defined. *Spicules* slender, alate, expanding distally like a small spoon which is distinctly recurved dorsally, 0·36 to 0·38 mm. long with accessory piece 0·16 mm. long bearing at its proximal end a small dorsally directed spur pointing at a right angle to main shaft.

The types of the three new species described above are in the British Museum (Natural History).

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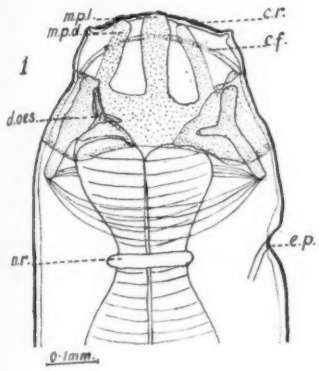
EXPLANATION OF PLATE III.

LETTERING TO FIGURES.

an. anus; *c.f.* cuticular flap limiting mouth opening; *c.r.* corona radiata; *d.oes.* duct of dorsal oesophageal gland; *e.p.* excretory pore; *i.pl.* internal plate of mouth; *l.d.* externo-dorsal ray; *m.p.d.* submedian dorsal pupilla; *m.p.l.* lateral pupilla; *n.r.* nerve-ring; *oes.* oesophagus.

Fig. 1. *Diaphanocephalus willeyi.* Head (lateral).
Fig. 2. *D. willeyi.* Head (dorsal).
Fig. 3. *D. simus.* Head (lateral).
Fig. 4. *D. simus.* Head (dorsal).
Fig. 5. *D. obliquus.* Head (dorsal).
Fig. 6. *D. obliquus.* Head (lateral).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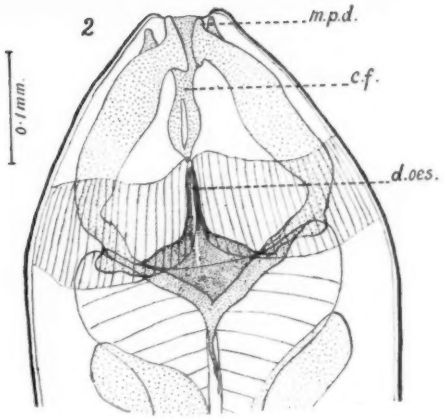
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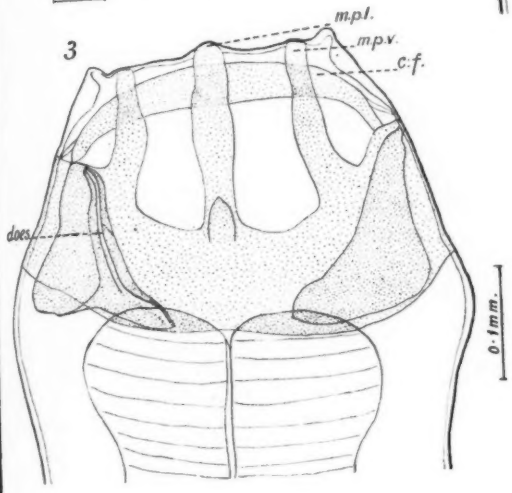
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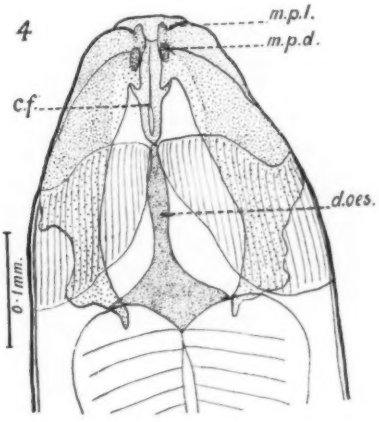
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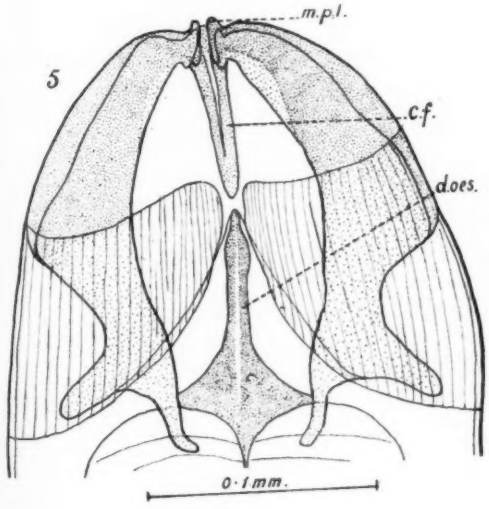
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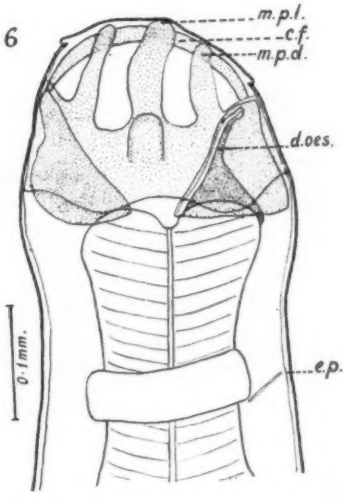
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DIPTERA, BOMBYLIIDAE AND MYIODARIA (*COENOSIINAE, MUSCINAE, CALLIPHORINAE, SARCOPHAGINAE, DEXIINAE, TACHININAE*), FROM THE SEYCHELLES AND NEIGHBOURING ISLANDS.

By Professor MARIO BEZZI (Turin).

(With 9 Text-figures.)

[This paper is the final report on the Diptera collected by the Percy Sladen Trust Expedition under Professor J. Stanley Gardiner, F.R.S., in the Seychelles and other islands of the Western Indian Ocean in 1905 and 1908–9. Many reports on the insects collected have appeared in the special series of volumes devoted to that Expedition, *Tr. Linn. Soc. London*, ser. 2 (Zool.), xii–xviii (from 1907 onwards), but it has not been possible to include all the entomological contributions in that series. I am greatly indebted to the Editor of *Parasitology* for accepting the present work, which was offered for publication in this journal as it deals with a number of parasitic forms—Bombyliidae, Sarcophaginae, Tachininae, etc. A list of all the other reports on Diptera collected by this Expedition, with full references, is given in *Ent. Monthly Mag.*, 58, 1922, p. 184.

Professor Bezzi's paper is of interest mainly from a systematic and geographical point of view. It also contains, however, some notes on the habits and times of appearance of certain species, and a record of the breeding of a Tachinid (*Sturmia inconspicua*, Meig.) from the larva of a Noctuid moth, *Plusia chalcytes*, Esper. (see p. 102); while in the forests of the Seychelles a ♂ of one of the new species of *Sarcophaga* was bred from a puparium found in the decayed outer leaf-base of an endemic palm (p. 89). The new genus of Tachininae, *Gynandromyia*, described in this paper, is erected to receive a male specimen which presents a curious assemblage of secondary characters usually associated with the female sex, blended with those belonging to the male sex. No want of symmetry has been observed, and there is no reason to suppose the insect to be a monstrosity. The author states that on a first, superficial examination, it might almost be taken for a hermaphrodite.

Turning to the question of geographical distribution: in the Bombyliidae, a family found throughout the world, the species of which are (in apparently all cases where the life-history is known) in their early stages parasitic on the

eggs or larvae of various other insects, only a single specimen was obtained in the mountainous Seychelles islands, and it belongs to a species (*Anthrax trimaculatus*, Wulp) widespread in both Oriental and Ethiopian Regions. But in the coral-atoll of Aldabra five species, representing four genera, were collected; one of these is described as new, the others are referred to species known either from Madagascar, the Mascarene Islands, or Africa, or even more widely distributed.

Concerning the Muscinae and other subfamilies designated "middle and higher MYIODARIA," a report on certain sections by the late Professor P. Stein had already appeared in 1910: but the species therein discussed are listed by Professor Bezzi in the present paper, so that a complete faunistic review of these groups of flies is given. Fifty distinct forms are thus enumerated from the several groups of islands under consideration. Ten of these are here described as new and a new genus is erected to contain one of them (see above). Eight of the new forms are from the Seychelles, and 12 of the species described by Stein in 1910 are also known only from those islands, so that 20 species in all are so far recorded only from that archipelago. The total number of species here enumerated from the Seychelles (including forms also known from elsewhere) is 39. Giglio-Tos (*Ann. Soc. ent. France*, 1895, pp. 361–4) recorded six species among the Diptera collected by Alluaud in 1892; four of these are included in the material obtained by the Percy Sladen Trust Expedition, but two (*Sarcophaga albofasciata*, Macq., and *Atherigona quadripunctata*, Rossi) are not recorded in the reports on these later collections, and thus the total number of species reported as occurring in the Seychelles is 41. The other two species described as new by Professor Bezzi (*Sarcophaga pyrrhopoda* and *Cosmina calida*) are recorded only from Aldabra.

Twenty-eight of the species enumerated are more or less widespread. They were found by the Expedition, some in the Seychelles, others in Aldabra, the Amirantes, Farquhar, Chagos, etc., and certain of them in several of these groups of islands. Their range outside the area visited by the expedition is (so far as known) very varied, and may be briefly summarized as follows: *Oriental*, 5 species; *Ethiopian Region*, 4; *Madagascar*, 1; *Mascarene Is.*, 2; *Europe and Mediterranean Countries*, 3 (two of these determinations somewhat doubtful); *Canary Is.*, 1; *very widespread*, 12 (these last consist of four forms common to Europe and Africa, two common to Africa and the Oriental Region, two widely distributed throughout the warmer parts of the Old World, and four almost cosmopolitan). The smallness of the Madagascar-Mascarene element is noteworthy.

A first set of specimens, including the *types* of all the new species, will be presented to the British Museum, and a second series will be kept in the Cambridge University Museum.—HUGH SCOTT.]

I. BOMBYLIIDAE.

Bombyliidae Homoeophthalmae.

Phthiriinae.

1. *Geron hybridus*, Meigen, 1804.

Several specimens of both sexes were collected; they are a little smaller than usual, but in other respects they are typical. It is a Mediterranean species, widely spread over the Ethiopian Region.

Loc. Aldabra: swept off coarse grass at Île Michel at sunset, x. 1908 (Fryer).

Bombyliidae Tomophthalmae.

Anthracinae.

2. *Anthrax trimaculatus*, Van der Wulp, 1868.

One female specimen was collected; its wing-pattern differs from that of the typical form in having no clear stripe running into the dark basal part; and moreover in having the infuscation of the first basal cell continued to the end and there united with the brown border of the discal cross-vein, the typical brown tooth being thus not isolated. The species is widely spread over the Oriental and Ethiopian Regions.

Loc. Seychelles: Mahé; probably from cultivated country; the only Bombyliid from the Seychelles proper in the whole collection.

3. *Anthrax fuscipennis*, Ricardo, 1903.

Anthrax muscarius, Klug, 1832, *nec* Pall. in Wied., 1818.
Anthrax dentatus, Becker, 1906.

One female specimen, wholly typical. The species is known from East Africa and Sokotra.

Loc. Aldabra, 1908 (Fryer).

Both the above named species of *Anthrax* belong, according to some authors, to the genus *Argyramoeba*.

Exoprosopinae.

4. *Villa sexfasciata*, Wiedemann, 1821.

Several specimens of both sexes were collected. I have seen the present species also from Mauritius; but the possibility is not excluded that all these specimens belong to a species different from the true *sexfasciata*, originally described from S. Africa. The species *unifasciata*, Macq., *leptopus*, Thoms., *madagascariensis*, Macq., and *ruficeps*, Macq., seem all to be distinct, judging from the descriptions.

Loc. Aldabra, 1908 (Fryer). Assumption I., 1909 (Dupont). Mascarene Islands.

5. *Exoprosopa* (*Defilippia*) *arcuata*, Macquart, 1847.

About fifteen specimens of both sexes of this Madagascan species of the *grandis*-group. In the male the dark wing-pattern is more extended than in the female.

Loc. Aldabra; "appeared first at end of November, 1908, and became common in the wet season in December; prefer shady places" (Fryer).

6. *Exoprosopa* (*Exoprosopa s. str.*) *famula*, n. sp.

A small species of the *stupida*-group with hyaline wings; it is near *E. serva* from Arabia, but differs in the absence of hair on the front coxae and in the different form of the discoidal cell of the wings.

♂. Length of body 7–7·5 mm.; of wing 6·5–7 mm. *Head* entirely black and rather shining, the mouth-borders only being rather broadly yellowish. Occipital border broad, with a deep middle furrow, clothed with scattered white scales, forming a white stripe along the eye-margin, more developed near the indentation; central fringe short and whitish. Eyes with the bisecting line extended about to the middle. Frons very narrow behind, the eyes about

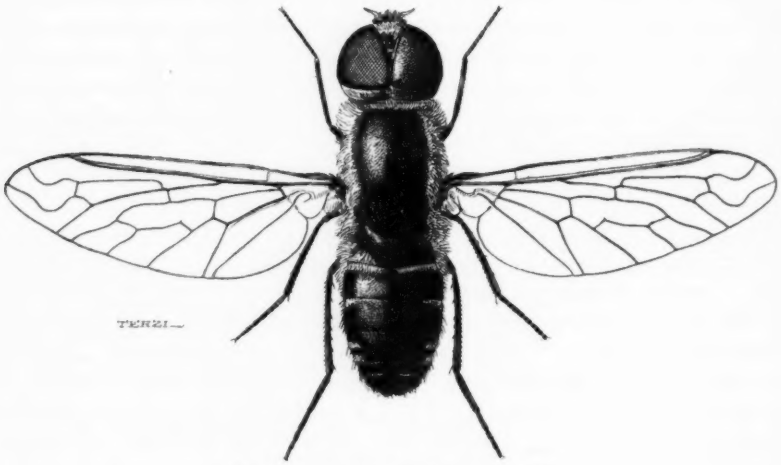

Fig. 1. *Exoprosopa famula*, n. sp., ♂ × 8.

touching beneath the ocellar tubercle, separated by a streak not broader than one ocellus; it gradually widens forwards, and is clothed with black, short, dense, erect hairs, and on the front third with white scales. Face bluntly conical, rounded, with short black hairs and scattered whitish scales. Antennae short, widely separated at base, entirely dark reddish; first joint with black hairs; second joint of globular shape; third joint conical, longer than the two first joints together, gradually tapering into a not thin point, without distinct terminal style. Proboscis short and thick, black, not at all projecting, with broad terminal flaps. *Thorax* and scutellum entirely black, a little shining; hairs and dust entirely whitish, black hairs or bristles being quite wanting; collar and notopleural tufts dense and long; pleurae with long hairs, the sternopleura with shining scales below the hairs. Squamulae dirty whitish, with a white fringe of broad scales; halteres white. *Abdomen* with parallel

sides and rather obtuse behind; it is clothed and coloured like the thorax, with some black hairs only at the sides near the end; first segment with dense white tufts at sides; the white scales seem to be disposed in narrow transverse bands at the base of the 2nd and of the 3rd segment, and to cover almost the whole of the last segments. Genitalia black, placed at the left side; venter quite black, with white scales. *Legs* black, with the four anterior tibiae reddish. Coxae of the front pair scaled but devoid of hairs; femora thin, with long dark hairs outwardly; tibiae thin and smooth, as long as femora; tarsi only a little longer than a half of the tibia, with short, less numerous, rather rigid hairs. The other legs with white scales on femora; hind femora not spinose below; tibiae with well developed black spicules, those of the hind pair with a rather dense fringe of hairs on the outer side; claws black, with reddish base, and with a short, stout, basal tooth. *Wings* hyaline and iridescent, with yellowish veins, which are darkened outwardly. Basal hook thin and pale yellowish; basal comb rather small and short, yellowish, with a thin black border. Second longitudinal vein originating just above the discal cross-vein or a little behind, with a deep terminal loop; discal cross-vein placed before the middle of the discoidal cell; first posterior cell broadly open at end, being nearly twice as broad near the discal cross-vein as at the base; 2nd and 3rd posterior cells of about same breadth at end, the 4th being the broadest of all; discoidal cell proportionally broad, $2\frac{1}{2}$ times longer than broad, with nearly parallel sides, rather acute at end, its terminal cross-vein being placed obliquely; anal cell rather broadly open at end. Axillary lobe broad; alula rounded, whitish, with a short white fringe.

Loc. Aldabra: 1908 (Fryer), type ♂, three other ♂ and one ♀.

II. MYIODARIA.

Of this great section of cyclorrhaphous flies I have received for examination only representatives of the middle and of the higher groups; those of the lower groups have been worked out by Lamb, Collin and others. Even of the middle Myiodaria the late Professor P. Stein published an account[1], dealing with 20 species of Anthomyiidae; and in the same paper he worked out three species of Calliphorinae. For completeness, I think it better to mention in the present paper the species published by him, even if they are not included in the material sent to me: these species are distinguished by an asterisk[2]. Owing to the present confusion in the classification and nomenclature of the groups, I have followed here the divisions adopted in the *Kat. paläarkt. Dipt.* III, 1907, by Bezzi and Stein, inverting the order, *viz.* going from the lower to the higher forms.

[1] *Trans. Linn. Soc. London*, ser. 2 (Zool.), XIV, 1910, pp. 149–63.

[2] The intention was to submit certain sections of the group to Professor Stein, reserving the other sections, which form the bulk of this present report, to be studied at a later date. But a few specimens which should have been sent to Stein were overlooked, whence it has resulted that in the genus *Musca* some species were studied by him in 1910, while two others have been added to the list by Professor Bezzi.—H. S.

Muscidae.

Coenosiinae.

Coenosiinae coenosiaeformes.

1. **Coenosia pallipalpis*, Stein, *op. cit.* p. 160, 1910 (Seychelles).
2. **Coenosia exigua*, Stein, *op. cit.* p. 161, 1910 (Seychelles).
3. **Pygophora lobata*, Stein, 1900; *op. cit.* p. 162, 1910 (Seychelles; Singapore; New Guinea).

Coenosiinae hylemyiaeformes.

4. **Anthomyia amoena*, Macquart, 1851; Stein, *op. cit.* p. 160, 1910 (Seychelles; Aldabra; Madagascar).

Muscinae.

Muscinae coenosiaeformes.

5. **Lispa leucospila* (Wiedemann).

   Coenosia leucospila, Wiedemann, 1830.
   Lispa pectinipes, Becker, 1903; Stein, *op. cit.* p. 159, 1910.
   Lispa lateralis, Stein, 1906.

(Aldabra; also Java, widespread in Africa, etc.; originally described from "Ostindien.")

6. **Atherigona* (*Acritochaeta*) *excisa* (Thomson).

   Coenosia excisa, Thomson, 1868.
   Acritochaeta trilineata, Stein, 1900; *id., op. cit.* p. 159, 1910.

(Seychelles; also Java, New Guinea, etc.; originally described from Ross Island.)

7. **Atherigona* (*Acritochaeta*) *maculipennis*, Stein, *op. cit.* p. 158, 1910 (Seychelles).
8. **Atherigona bimaculata*, Stein, *op. cit.* p. 157, 1910 (Seychelles).
9. **Atherigona laeta* (Wiedemann).

   Coenosia laeta, Wiedemann, 1830.
   Atherigona scutellaris, Stein, 1903; *id., op. cit.* p. 158, 1910.

(Seychelles; Egypt; originally described from "Ostindien.")

Muscinae ariciaeformes.

10. **Limnophora fasciculata*, Stein, *op. cit.* p. 155, 1910 (Seychelles).
11. **Fannia ? leucosticta*, Meigen, 1826; Stein, *loc. cit.* (Seychelles; the typical *F. leucosticta* is a European and Mediterranean insect).
12. **Ophyra chalcogaster*, Wiedemann, 1830; Stein, *loc. cit.* (Seychelles; Singapore; Java; New Guinea).
13. **Ophyra nigrisquama*, Stein, *op. cit.* p. 154, 1910 (Seychelles).
14. **Alluaudinella bivittata*, Macquart, 1843; Stein, *op. cit.* p. 151, 1910 (Seychelles; Mauritius).
15. **Mydaea fasciculifera*, Stein, *op. cit.* p. 153, 1910 (Seychelles).
16. **Mydaea mediana*, Stein, *op. cit.* p. 152, 1910 (Seychelles).
17. **Mydaea compressipalpis*, Stein, *op. cit.* p. 151, 1910 (Seychelles).

18. **Stomoxys glauca*, Grünberg, 1906; Stein, *op. cit.* p. 150, 1910 (Seychelles; West Africa).

Muscinae muscaeformes.

19. **Musca fasciata*, Stein, *op. cit.* p. 149, 1910 (Seychelles).

20. *Musca humilis*, Wiedemann, 1830.

Musca vetustissima, Walker, 1849.
Musca angustifrons, Thomson, 1868.
Musca bivittata, Thomson, 1868.

One female specimen of this widely distributed species, which is common from Africa throughout Asia to Australia.

Loc. Aldabra, 1908–9 (Fryer).

21. *Musca albomaculata*, Macquart, 1843; Bezzi, *Boll. Lab. Zool. Portici*, VI, 1912, pp. 86, 89.

One female specimen of this form, taken in the sense of my paper of 1912. It was described by Macquart from Mauritius, and recorded by me from South-East Africa (Lorenzo Marques, etc.). Dr Villeneuve (*Ann. South African Mus.* XV, 1916, p. 513) states that the type of *albomaculata* is identical with *convexifrons*, Thomson.

Loc. Aldabra, 1908–9 (Fryer).

22. **Musca domestica*, Linn. 1758.

Musca niveisquama, Stein (*nec* Thomson[1]), *op. cit.* p. 149, 1910.

(The series collected by the Percy Sladen Trust Expedition was from the Seychelles, Amirantes, Coetivy and Cargados Islands.)

23. *Synthesiomyia nudiseta* (Van der Wulp, 1883); Bezzi, *Societas Entomologica*, XXVI, 1911, pp. 65–7; Stein, *Arch. Naturg.* 83, 1917, Abt. A., Heft 1, p. 111 (1919).

Cyrtoneura nudiseta, Van der Wulp, *Tijdschr. v. Ent.* XXVI, 1883, p. 42.
Synthesiomyia brasiliana, Brauer und Bergenstamm, *Denkschr. Ak. Wien*, LX, 1893, pp. 96, 110.
Hyadesimyia grisea, Giglio-Tos, *Boll. Mus. Torino*, VIII, 1893, p. 5; *id.*, *Ditt. Messico*, IV, p. 8, 1895.
Gymnostylina schmitzi, Becker, *Mitt. Zool. Mus. Berlin*, IV, 1908, p. 196.

Two typical female specimens of this very important and widespread tropical species have been submitted to me: [several other specimens were also obtained]. In 1911 (*l. c.*, above) I published a short paper dealing with its synonymy and distribution. More recently (*l. c.*, 1919) Stein has added several other synonyms. In 1911 I recorded the species from South Africa (Natal); and Tyler Townsend, who considers it as belonging to the higher Myiodaria, has recorded it from Peru.

[1] [Before Professor Bezzi's manuscript was received, Major E. E. Austen had in conversation already expressed the opinion that the examples determined by Stein as *niveisquama*, Thoms., did not agree with Thomson's description of that form, and had suggested that the material might be referable to *M. flavinervis*, Thoms.—H. S.]

The known distribution is at present as follows. Africa: Madeira, Transvaal, Natal. America: Southern United States, Mexico, Peru, Brazil, Chile, Paraguay, Argentine. Pacific Islands: Honolulu. Australia: Townsville, N. Queensland, recently received by me from Dr Hill.

Loc. Seychelles, Mahé: Cascade Estate, about 1000 ft., 2 ♂, 3 ♀.

Tachinidae.
Calliphorinae.

24. *Lucilia argyrocephala*, Macquart, 1846.

Several specimens of this species, which is widely spread over the Ethiopian Region.

Loc. Cargados Islands; Establishment I., 26. viii. 1905. Also Chagos Islands; Salomon Atoll, 24. v. 1905, one example with the note "common" (det. by C. G. Lamb).

25. *Lucilia cyaneomarginata*, Macquart, 1850; Giglio-Tos, *Ann. Soc. ent. France*, 1895, p. 362.

This is the form recorded in 1895 from the Seychelles by Giglio-Tos, under the present name; it was originally described from Java. I think that it is only a form of *L. caesar*, and give the following description of the specimens in the collection under review.

♂♀. A species of relatively greater size, reaching in the female a length sometimes over 10 mm., but usually 7–9 mm. Eyes of the male narrowly separated, the white orbits between them being in contact on the middle of the frons; upper areolets distinctly enlarged in both sexes. Frons of female relatively narrow, with parallel sides, narrower than one eye, about $\frac{1}{4}$ as broad as the head; middle band twice as broad as one orbit, velvety black, but dark reddish in front. The ocellar plate and the vertical part of the orbits are a little metallic. Antennae black; third joint nearly four times as long as the two basal joints together, distinctly reddish near the base and on the inner side. Palpi blackish or dark reddish-brown. Parafacialia silvery, with a reddish-brown spot below; facial ridges ciliated to above the middle. Peristomialia black. There is only one pair of strong ocellar bristles, with several hairs behind; the male has no more than 8–9 pairs of inner orbitals, the upper ones becoming very small; the female has also 8–9 pairs, but all very strong, and moreover two pairs of strong exterior orbitals. *Thorax* with black prothoracal stigma; *dc.* bristles 3 + 2, *ac.* 2 + 2; scutellum with 1 basal, 1 preapical, 1 apical and 1 discoidal. Calypters whitish; halteres yellowish. *Abdomen* with less developed apical bristles; male genitalia prominent, with rounded paralobes, and with blunt, curved unci. Venter of male with tufts of black hairs. *Legs* black, with reddish trochanters. *Wings* greyish-hyaline; no costal bristle; first vein bare; base of third vein with 8–9 setulae above and below, extending to the middle of the distance from the small cross-vein; basal stem of radius bare. Fourth vein bent at an obtuse angle; apical cross-vein a little concave outwardly.

From *L. caesar* the present form differs in the dark palpi, and in the broad cyaneous margination of the hind borders of the middle abdominal segments.

Loc. Seychelles, Farquhar, Aldabra. Seychelles: Mahé, Silhouette and Dennis Islands; the examples from the two former islands are all from elevations of 1000–2000 ft., sometimes in the high, damp endemic forests; some of the Silhouette specimens frequented the inside of a camping-hut at 1500 ft., viii. 1908: the third island, Dennis, is an outlying, low coral-island of scarcely any elevation. Farquhar Atoll: 1 example, 1905. Aldabra: 1 specimen, 1908–9 (Fryer).

26. *Chrysomyia albiceps* (Wiedemann, 1819)[1].

This is in all probability identical with *Chrysomyia fasciata*, Macq., as recorded in 1895 by Giglio-Tos (*op. cit.* p. 362) from the Seychelles. The species is widely spread over the Ethiopian and Oriental Regions, as well as in Mediterranean countries.

Loc. Seychelles and Aldabra. Seychelles: one specimen from Long Island, vii. 1908, and many from Mahé (Forêt Noire district and Cascade Estate, both about 1000 feet, including one pair taken *in coitu* on 1. iii. 1909). Aldabra: 1907 (Thomasset); many examples, 1908–9 (Fryer).

27. *Chrysomyia megacephala* (Fabricius, 1794).

Musca dux, Eschscholtz, 1822.

This oriental species is very common in the Malay Archipelago to the Philippines, and in the Pacific Islands. The widely-spread species *bezziana*, Villeneuve, is very like it in the female sex, but has a whiter prothoracal stigma; the male has moreover the upper areolets of the eyes not enlarged, and thus belongs to the genus *Pycnosoma*.

Loc. Chagos Islands: Salomon Atoll, 24. v. 1905 and 22. vi. 1905.

28. **Rhinia apicalis* (Wiedemann, 1830); Stein, *op. cit.* p. 162, 1910 (Seychelles, Amirantes and Chagos; previously recorded from Canary Is.).

29. **Rhinia scotti*, Stein, *loc. cit.* 1910 (Seychelles and Aldabra).

30. **Idiella cyanea*, Stein, *op. cit.* p. 163, 1910 (Seychelles).

31. *Cosmina calida*, n. sp.

Closely allied to *claripennis*, R.-D., as redescribed by me in 1909 (*Broteria*, p. 60, pl. ix, f. 39), and perhaps only a variety of it, but differing in the strong cupreous tint of the sides of the thorax and of the whole abdomen, in the black facial carina, and in the want of costal infuscation on the wings. *C. cuprina*, Bigot 1859, from Madagascar, appears also to be different, judging mainly from the notes of Brauer and of Villeneuve.

♀. Length of body 10 mm.; of wing 8 mm. *Head* entirely black; the narrow ocellar triangle and the parafrontalia are densely covered with grey dust, the parafrontalia being provided with rounded black dots placed in 2–3 irregular

[1] For synonymy of, and notes on, this and the following species see W. S. Patton, *Bull. Ent. Res.*, xiii, p. 110, 1922.

rows; middle band deep black, narrow, not broader than half of the parafrontalia. Face entirely shining black, rather prominent below, with a black basal carina between the antennae. Parafacialia grey dusted, with a shining, wrinkled, callous spot beneath; peristomialia grey dusted, with a shining callous black spot in the middle. Antennae black, reddish on second joint and on base of third, not extending below middle of face; third joint about $2\frac{1}{2}$ times as long as the two first joints together; arista long-plumose on both sides. Palpi broadly spathulate, long, flat, yellowish at base and on middle, black on the borders and at end; proboscis rather long, compressed, shining black. Vertical bristles curved behind; parafrontalia with three rows of short bristles, those of the exterior row being hair-like; one pair of basal orbitals, curved behind; ocellar well developed; parafacialia with a single row of hairs near the ridges; longer vibrissae placed above the mouth-edge, and over it there are three hairs only. The hairs of the peristomialia are black, but yellowish behind; occiput very concave, grey dusted in the middle; eyes bare, rather depressed in profile, with the areolets equally small, not banded. *Thorax* green on the middle, coppery on the sides and chiefly on the pleurae, shining, with a faint whitish dust on the back if viewed from behind, this dust forming five very narrow parallel longitudinal stripes in front of the suture. Scutellum green, coppery at end. On the back of the thorax there are regular longitudinal rows of hairs, about 10 rows between the dorsocentral lines; the bristles are less developed, only two pairs of *dc.* and two pairs of *ac.* being distinct just in front of the scutellum; there is a less distinct pair of *dc.* in front of the suture; there are seven *mpl.* placed in a row at posterior border of mesopleura; *st.* 1 + 1, long. Scutellum with 1 basal, 1 preapical, 1 apical and 1 small discoidal. Upper squama of calypters white, lower squama dirty and bare. *Abdomen* entirely coppery, green only on middle and at hind borders of segments, clothed with a faint whitish dust and with equally short black hairs, like those of the thorax, without bristles. Venter coppery-green, densely grey dusted, with open basal plate. *Legs* entirely black and black-pilose, but the femora green on the outer side; front tarsi dilated. *Wings* entirely greyish-hyaline, not at all infuscated along the fore border; veins yellowish, but the costa black; no costal bristle. Third longitudinal vein with 1–2 short bristles at its extreme base; basal stem of radius with 5–6 bristles; bend of fourth vein obtuse, apical cross-vein rather straight; hind cross-vein S-shaped, placed near the bend of the fourth. First posterior cell open, its terminal opening being about as broad as the length of the small cross-vein.

Loc. Aldabra: ix. 1908 (Fryer; a single ♀, the type).

Sarcophaginae.

Sarcophaga.

Only a very small number of species of this important genus has been described in recent times from the region under review; and the numerous species described by the old authors are not recognizable by modern methods.

I sent the material of my collection to the late Dr Böttcher and to Dr Parker, but I have not received reports about it from them.

From the Mascarene subregion are described or recorded by Robineau-Desvoidy, Macquart, Thomson, Smith, Bigot and Giglio-Tos the following 13 species: *cognata*, R.D., *mauritiana*, Macq., *immaculata*, Macq., *albofasciata*, Macq. (recorded by Giglio-Tos, *op. cit.* 1895, p. 361, from the Seychelles, but not obtained by the Percy Sladen Trust Expedition), *longicornis*, Macq., *lasiostyla*, Macq., *brevigaster*, Macq., *claripennis*, Thoms., *madagascariensis*, Macq., *mutata*, Smith, with the three European species *cruentata*, *haemorrhoidalis* and *sinuata*. None of the species in the collection submitted to me can be referred to any of the above-named forms, with the exception of *haemorrhoidalis*. But Dr Villeneuve has described[1] several species from Sokotra and South Arabia which are to be found among the material under review; some other species in this collection are Oriental or Mediterranean, and seem to be widely spread in Africa. The species before me can be distinguished as follows:

1 (4). Parafrontalia, parafacialia and peristomialia of a deep black colour, with rounded, silvery spots; hairs of the posterior part of the peristomialia entirely black; longitudinal dark stripes on back of thorax shining, and more or less metallic-bluish or greenish; acrostichal bristles not developed, never in front of the scutellum; parafacial hairs thin, placed in but one row.

2 (3). Arista shortly pilose; abdomen metallic green, almost entirely shining, with tessellation not developed; *dc.* strong, 3 + 3; alar tegulae aureous; anal plate of the female black . . . . . *metallescens*, n. sp.

3 (2). Arista long-pilose; abdomen not shining green, with the usual tessellation; *dc.* less developed, the postsutural ones being distinct; alar tegulae white; hypopygium of male and anal plate of female red *spilargyra*, n. sp.

4 (1). Sides of head greyish- or yellowish-dusted, without silvery spots; posterior peristomial hairs white, at least on the chin; thoracic stripes dull black, or if a little shining, always black.

5 (6). Legs entirely red; wings with a diffused yellowish tint on the basal half; abdomen uniformly grey, without shimmering areas; parafacial hairs in more than one row inferiorly; two pairs only of exterior fronto-orbital bristles, one of which is bent forwards. . . . . *pyrrhopoda*, n. sp.

6 (5). Legs quite black, or only with dark reddish tibiae; wings never extensively yellowish; abdomen with the usual shimmering spots; parafacial hairs typically in one row; frons of the female with three pairs of exterior orbitals, two of which are bent forwards.

7 (8). Antennae and palpi entirely red; occiput with white hairs only below the unique row of postocular black cilia; *dc.* not developed, those before the suture being quite indistinct; peristomial hairs very numerous and of a pure white colour . . . . . *ruficornis*, Wied.

[1] In Becker, *Dipt. aus Süd-Arabien und Insel Sokotra, Denkschr. Ak. Wien, Math.-nat. Kl.*, LXXI (Halfband 2), 1910. See footnote on p. 18.

8 (7). Antennae and palpi quite black, sometimes a little dark reddish; occiput with black hairs, or with more than one row of postocular black cilia.

9 (14). Hypopygium at least with the second segment red; anal plates of female red.

10 (13). Hind tibiae of male with dense and long villosity; penis without broad terminal appendages.

11 (12). No prescutellar acrostichal bristles . . *haemorrhoidalis*, Fall.

12 (11). One pair of well developed prescutellar bristles . *dux*, Thoms.

13 (10). Hind tibiae with scarce and scattered villosity; penis with three broad terminal appendages . . . . . *trifolia*, Villeneuve.

14 (9). Hypopygium wholly black; anal plates of female black.

15 (16). Hind tibiae of male with dense villosity . . *tuberosa*, Pand.

16 (15). Hind tibiae bare or with only a few scattered hairs.

17 (18). Acrostichal bristles not distinct before the suture; second abdominal segment with median macrochaetae; forceps obtuse at end, with a thin median spine . . . . . *spinosa*, Villeneuve.

18 (17). Presutural acrostichals well developed; second abdominal segment without median macrochaetae; forceps regularly pointed, destitute of terminal spine . . . . . *depressifrons*, Zett.

32. *Sarcophaga metallescens*, n. sp.

A very distinct species, on account of the silvery spots on the sides of the head, and of the metallic colour of the body, chiefly of the abdomen. Of described species, only *Phrissopoda splendens*, Macquart, seems to resemble this one, but it is said to be from Chile. The present species seems to be allied to several of those from the Hawaiian Islands, described by Grimshaw under the generic names *Dyscritomyia* and *Prosthetochaeta*.

♀. Length of body 10 mm.; of wing 9 mm. *Head* entirely black, a little shining bluish on the upper occipital border and on the upper part of the parafrontalia. The middle of the occiput is covered with shining white dust. Frontal stripe deep black; ocellar triangle deep black, bordered with grey; parafrontalia silvery dusted on the front half and with a few black hairs. Parafacialia deep black, with a silvery spot on the middle; clypeus with white dust, and with a distinct carina on the upper half between the antennae. Peristomialia deep black, with a broad, rounded, silvery spot on the middle and clothed with entirely black hairs, even posteriorly. Antennae black, with the third joint about twice as long as the two first joints together; arista longer than the antenna, rather shortly plumose on the basal half only. Palpi black. Only one row of long black cilia behind the eyes; outer *vt.* shorter than the inner and curved outwardly; *oc.* strong; three pairs of strong outer *or.*, the basal one bent backwards, the two apical ones bent forwards; parafacial cilia thin and placed in one row; facial ridges with only a few short hairs above the vibrissa. Proboscis shining black. All the hairs of the hind part of the

head are black, even below the posterior eye-margins, but shining silvery towards the middle. *Thorax* metallic bluish and rather shining. On the back the white dust is disposed in four longitudinal stripes, two of which are within the dorsocentral lines, separated by the space of six rows of acrostichal hairs; the two other stripes are broader, placed along the notopleural lines, extending from the humeri to the root of the wings. Pleurae with patches of dust on middle of mesopleura and of sternopleura. Prothoracic stigma of a deep black colour. The macrochaetae are well developed; *dc.* 3 + 3, all strong, even the presutural ones; no distinct *acr.* in front of scutellum, but only eight rows of hairs; *st.* long and strong, placed according to the formula 1.1.1, the middle one a little shorter. Scutellum shining bluish-green, with white dust at hind border and with black hairs; two pairs of lateral, and one pair of discoidal, bristles; no apical bristles, as is usual in the females of this genus. Calypters white and white-fringed, bare above; halteres black. *Abdomen* shining green, the white dust being limited to the base of each segment and near the sides, but not forming the usual tessellation. First and second segments with only a strong bristle on each side, but without central bristles; third segment with a complete row of about 10 bristles at hind border; fourth segment also with a complete row of 12–14 bristles; anal plates black. Venter like the dorsum, but darker and clothed with grey dust; hind border of each sternite with a row of short bristles. *Legs* entirely black, only the femora a little dark bluish outwardly and above; they are covered with black hairs and black bristles; pulvilli yellowish, claws black. *Wings* greyish-hyaline, only a little darker at the extreme base. Costal bristle very short. The veins are black; the first is bare, the third at base with 9–10 short bristles, extending to the middle of the distance before the small cross-vein; basal stem of radius bare. The extreme base of the costa is covered by a well developed, aureous tegula. Fourth longitudinal vein less curved above the bend, the latter being about rectangular.

Loc. Seychelles. Mahé: Cascade Estate, about 1000 ft., type ♀ and four other ♀ examples.

33. *Sarcophaga spilargyra*, n. sp.

Resembling the preceding species in the coloration of the head, but with the body not metallic. Of described African species, only *Myiophora argyrostoma*, R.-D., from the Cape, and *M. cognata*, R.-D., from Mauritius, show a like coloration of the head.

♂♀. Length of body 9–10 mm.; of wing 7·5–8 mm. *Head* shaped, coloured and haired as in the preceding species, and with the same bristles; but the plumosity of the antennal arista is much longer and the bare terminal portion of the arista is much shorter. The frons of the male is half as broad as that of the female, measuring only $\frac{1}{5}$ of the breadth of the head. Palpi and proboscis black. *Thorax* not metallic, but with the three dark longitudinal stripes rather shining and distinctly bluish, chiefly in the male; the four whitish longitudinal

stripes between them are more densely pollinose, and the notopleural stripes are distinctly broader; pleurae black, a little shining bluish, with white patches on propleura, pteropleura and sternopleura; prothoracic stigma distinctly yellowish towards the middle. Scutellum greyish pollinose, with a broad middle longitudinal dark stripe in continuation of that of the back of the mesonotum. Macrochaetae much less developed than in the preceding species; no *acr.*, the hairs being disposed in about 12 longitudinal rows, two of which on each side are placed on the whitish stripe (while in the preceding species each stripe bears but a single row); of well developed *dc.* there are only two postsutural pairs, the presutural ones being indistinct in the male, and represented

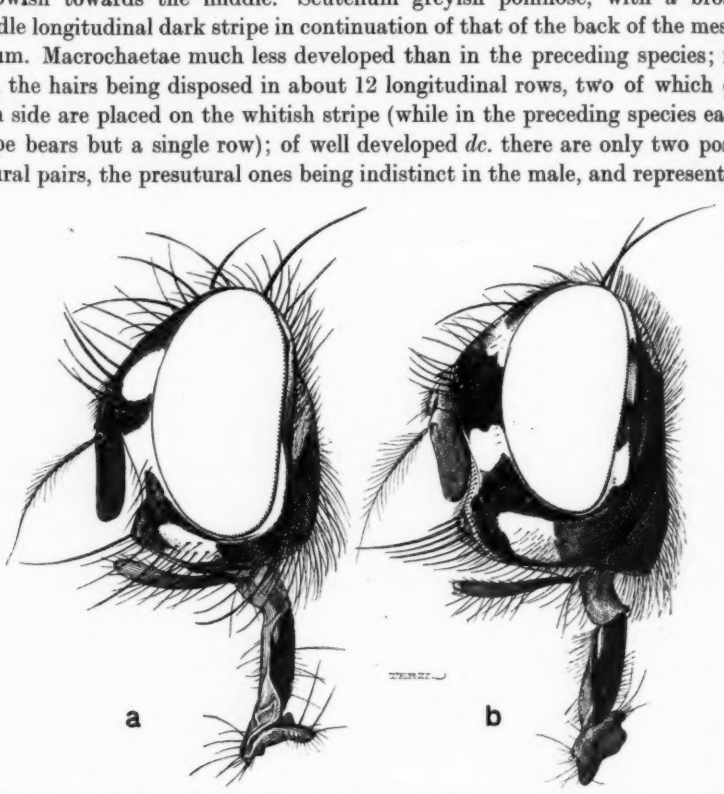

Fig. 2. Heads in profile of *a*, *Sarcophaga metallescens*, n. sp.; *b*, *Sarcophaga spilargyra*, n. sp., both ♀, × ca. 17; [the exact outer limits of the shimmering silver spots vary somewhat according to the direction from which the insect is viewed].

by two small hairs in the female. Scutellum destitute of discoidal bristles, with only the two pairs of lateral ones in both sexes, and moreover in the male with the apical decussate pair well developed. Calypters white and white-margined; halteres black, with yellow stalk. *Abdomen* not metallic, but distinctly shining bluish, with well developed tessellation; first and second segments with lateral macrochaetae only; third segment with one middle pair, and 2–4 on sides; fourth segment with a complete row. Venter like the dorsum, with the sternites grey-pollinose and black-pilose, but without bristles at hind border. Hypopygium with the first segment black, partly grey dusted, black-haired but without bristles at hind border; second segment shining red, with erect long black

hairs; forceps shining black, gradually attenuated into a regular, slightly curved point, densely black-villose at base below; claspers rostriform; penis with a semilunar termination; fifth abdominal sternite inwardly with brushes of short spines. Anal plates of the female red, in form of a complete ring, not at all emarginate above in the middle, with black bristles on sides. *Legs* black, grey dusted, with black hairs and black bristles; all the femora of the male are densely villose below, but with distinct bristles between the villosity; middle tibiae without, hind tibiae with, dense villosity; pulvilli of male blackish above, yellowish on sides, those of female wholly yellowish. *Wings* greyish-hyaline, with black veins; the basal tegula is whitish, not aureous; bend of fourth vein deep and acute, as is usual, the apical cross-vein retreating much at base. First vein bare; third vein setose over the middle of the distance from the base to the small cross-vein. No costal bristle.

Puparium of cylindrical shape and dark red in colour, measuring 7·5 mm. in length but without the operculum. The pseudopodial areas are microscopically granulose. Posterior stigmatic depression very deep, circular, surrounded by 5–6 small fleshy tubercles on each side, the upper ones being more prominent; and moreover there are two isolated tubercles in front above.

Loc. Seychelles: Silhouette, Mahé. Silhouette: type ♂ from Mare aux Cochons plateau, over 1000 feet, ix. 1908, and a second ♂ from the same locality bred from a puparium found in a decayed outer leaf-base of a palm (*Stevensonia*), 7. ix. 1908. Mahé: type ♀ from Cascade Estate, about 1000 feet; one ♂ from the same place; one ♂ from Mare aux Cochons district, 1000–2000 feet; two ♂ collected in 1905, without detailed records of locality.

34. *Sarcophaga pyrrhopoda*, n. sp.

Distinguished by the quite red legs, the unspotted abdomen and yellowish wings. The present species belongs in all probability to the *Sarcophila*-group, but is different in the shape of the head from *Parasarcophila* (*Agria*) *rufipes*, Macq. The colour of the legs is truly red, not merely reddish as in *S. hirtipes*, Wied. (*rufipes*, W.).

♀. Length of body 10 mm.; of wing 8 mm. *Head* black, but densely clothed with whitish dust, not at all shining. Occiput wholly grey, black-haired, with the postocular cilia placed in but one row, with several black hairs below them. Frons less than $\frac{1}{3}$ the breadth of the head; frontal middle stripe black, but in certain lights densely grey-pollinose; parafrontalia whitish-pollinose, with scattered black hairs. Parafacialia densely whitish-pollinose, with the cilia placed inferiorly in about three irregular rows; clypeus densely pollinose, with no distinct carina above, ciliated on the sides to about the middle of its length. Peristomialia densely pollinose, clothed with black hairs on fore half, and with yellowish ones posteriorly. Antennae black, but the second joint a little dark reddish at end above, and the third grey-pollinose; they are rather short, extending only to about $\frac{2}{3}$ of face, the third joint being less than twice as long as the first two joints together; arista with long

plumosity, its bare terminal portion being rather short. Palpi and proboscis black. Chaetotaxy normal; two pairs of *vt.*, two pairs only of outer *or.*, the basal bent behind and the anterior one bent forwards. *Thorax* entirely and densely grey-pollinose, not at all shining; there are only uncertain traces of five longitudinal dark stripes, three broader in the usual position, and two very narrow in the spaces between the preceding three; pleurae unspotted. Prothoracic stigma yellowish. Macrochaetae less developed; no *acr.*, the hairs being disposed in 12–14 longitudinal rows; of the *dc.* only the two postsutural pairs are distinct, those before the suture being less visible, or indicated only by three small hairs; *st.* 1.1.1, the middle one being half as strong as the others. Scutellum pollinose, with a dark middle longitudinal

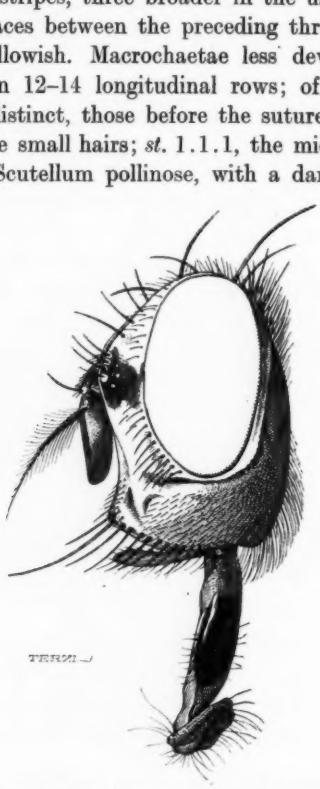

Fig. 3. *Sarcophaga pyrrhopoda*, n. sp., ♀, head in profile, × ca. 17.

stripe in continuation of that on the mesonotum; there are only two pairs of macrochaetae on the sides, the discoidal and the apical ones being wanting. Calypters whitish-yellow; halteres yellowish. *Abdomen* entirely grey-pollinose, opaque, with no distinct tessellation; anal plate entire, red, not emarginate above, ciliated with 4–5 black bristles at hind border, but bare on the middle. First and second segments without macrochaetae, even on the sides; third segment with one middle pair, and two pairs on each side; fourth segment with 8, forming a complete row. *Legs* wholly red, even on the coxae, the last tarsal joints only being blackened; they are thinly whitish-pollinose, with black hairs and black bristles; claws red, with black tips; pulvilli yellowish. *Wings* greyish-hyaline, with a diffused yellowish tint on the basal half; basal

tegulae whitish. Costa and veins yellowish; first vein bare; third vein with several hairs, close together, at base; apical cross-vein retreating, the bend being acute and deep.

Loc. Aldabra: one ♀, 1908–9 (Fryer).

35. *Sarcophaga ruficornis*, Wiedemann, 1830; Böttcher, *Deutsch. entom. Zeitschr.*, 1913, p. 370.

Very distinct from all the other species by its quite red antennae and numerous, pure white, peristomial hairs. The single male example agrees perfectly with Indian and Philippine specimens in my collection. The species is widely spread over the Oriental Region, and is known in India as causing severe forms of myiasis in man and animals. It is recorded here for the first time from the islands under review. This species has no *acr.*, and less developed *dc.*, bristles, the latter being represented only by two pairs of postsutural ones; hind tibiae of male with dense but short villosity. The black postocular cilia are placed in but one row, all the other occipital hairs being thin and white, a character unique among the species of *Sarcophaga* known to me.

Loc. Chagos Islands: one ♂, which flew on board H.M.S. "Sealark" at Peros Banhos Atoll, 22. v. 1905.

36. *Sarcophaga haemorrhoidalis*, Fallén, 1816; Böttcher, *Deutsch. entom. Zeitschr.*, 1913, p. 10, fig. 37; Aldrich, *Sarcophaga* and allies, 1916, p. 189, pl. ix, fig. 87.

A widely-spread species, of almost cosmopolitan distribution.

Loc. Cargados Islands: Siren I., 27. viii. 1905. Amirantes: Desroches I., 15. x. 1905. Seychelles: Mahé, Forêt Noire district and Cascade Estate, both about 1000 feet, 1908–9.

37. *Sarcophaga dux*, Thomson, subsp. *b.*, Parker, *Bull. Brooklyn entom. Soc.*, XIV, 1919, p. 44, fig. 9.

The present species is distinguished from the preceding by possessing well developed prescutellar bristles, and from *beckeri*, Villeneuve, by having the hind border of the first segment of the hypopygium provided with bristles; from the form *exuberans*, Pand., it is distinguished by having only two rows of black postocular cilia and the vestiture of the cheeks prevalently white. It is known from South Europe and seems to be widely spread over Africa.

Loc. Two examples from Mahé, Seychelles (Cascade Estate, about 1000 feet). [There is a further series of specimens not submitted to Prof. Bezzi, but determined by C. G. Lamb, including many from Mahé, one from Félicité, and one from Praslin, in the Seychelles; and one from Peros Banhos Atoll in the Chagos group (1905).]

38. *Sarcophaga dux*, Thomson, subsp. *tuberosa*, Pandellé, 1896; Böttcher, *Deutsch. entom. Zeitschr.*, 1912, p. 735, fig. 29 bis, *a*; Aldrich, *Sarcophaga* and allies, 1916, p. 232; Parker, *Bull. Brooklyn entom. Soc.* XIV, 1919, p. 44, figs. 3, 10.

Distinguished from the preceding form by the hypopygium being entirely black, and the vestiture of the cheeks black. Widely spread over Europe, Asia and N. America, and probably over Africa.

Loc. Seychelles. A couple of specimens from Mahé (Cascade Estate and Forêt Noire district). [Also two ♂ determined by C. G. Lamb, from Mahé and Dennis Island respectively.]

39. *Sarcophaga trifolia*, Villeneuve, in Becker, *Dipt. aus Süd-Arabien und Insel Sokotra, Denkschr. Ak. Wien, Math.-Nat. Kl.*, LXXI, 1910, p. 146 (Sep. p. 16), fig. 4[1]; Böttcher, *Deutsch. ent. Zeitschr.* 1913, p. 13.

Distinguished from the three preceding species by the very peculiar male genitalia, the dark reddish tibiae, and the scattered villosity of the hind tibiae. It is to be compared with the description of *S. tibialis*, Macquart, 1851. Described from Sokotra.

Loc. Seychelles. A male specimen from Mahé. Cascade Estate, about 1000 feet; and two ♂ from Long Island, off the coast of Mahé.

40. *Sarcophaga spinosa*, Villeneuve, *Bull. de la Soc. des Amis des Sci. Nat. de Rouen*, 1911, p. 9; Böttcher, *Deutsch. entom. Zeitschr.*, 1912, p. 726, fig. 22.

A very distinct species on account of the form of the forceps. The condition of the hind tibiae is the same as that found in *S. gymnocnemis*, Bezzi (*Denkschr. der med.-naturwiss. Ges. Jena*, XIII. 1908, p. 186), from South Africa. The present species is known from Syria, Egypt and South Europe.

Loc. Seychelles: two ♂ from Long Island, vii. 1908. [Providence (Farquhar Group): several doubtful specimens from Cerf Island, 3. x. 1905.]

41. *Sarcophaga depressifrons*, Zetterstedt, 1845; Böttcher, *Deutsch. entom. Zeitschr.*, 1913, p. 252, fig. 64.

Sarcophaga arvorum, Rondani (*nec* Meigen), 1860.

A small species distinguished from all the preceding ones in having well developed and complete acrostichal bristles. It is widely spread over Europe and Mediterranean countries; in 1892 (*Ann. Mus. civ. Genova*, XXXII, p. 188) I recorded it from Somaliland.

Loc. Seychelles. One male specimen from Long Island, vii. 1908; one doubtful female specimen from the same locality.

Dexiinae.

42. *Exogaster hemimelaena*, n. sp.

An elegant species, closely allied to *dimidiata* and *soror*, Wied., but distinct by the different abdominal pattern, and by the legs being half black and half red.

[1] [The first "Halfband" of vol. LXXI appeared in 1907 and contained other memoirs on the fauna and flora of South Arabia and Sokotra, but not the account of the Diptera. The latter is doubtless in the second half-volume, which had not been received (July 1922) either at Cambridge or in the Natural History Museum (London).—H. S.]

♂. Length of body 11 mm.; of wing 8 mm. *Head* reddish, white-pollinose on the sides, black on the upper half of the occiput. *Ocellar* triangle shining black; frontal stripe very broad, reddish-brown; frons as broad as $\frac{1}{4}$ of the head; parafrontalia very narrow behind and reddish like the parafacialia, rather shining, the latter with silvery dust; face reddish, white-pollinose, with a broad carina in the middle on the upper part; peristomialia broad, reddish, with white dust in front. Antennae narrow and long, as long as the face, entirely reddish; second joint elongated, about three times as long as the short first joint; third joint $2\frac{1}{2}$ times as long as the second, rectangular, truncate at end; arista reddish, as long as the third joint of the antenna, with the basal joints very short (as in the genus *Plesiocyptera*). All the bristles are black; one exterior *or.* on each side, towards the middle of the parafrontalia; vibrissae less developed and not decussate, and beyond them there are several bristly hairs; hairs of chin and of occiput white. Palpi not developed; proboscis quite reddish. *Thorax* entirely black, and a little shining; on the back are to be seen in front the beginning of two broad longitudinal stripes of white dust; on meso-

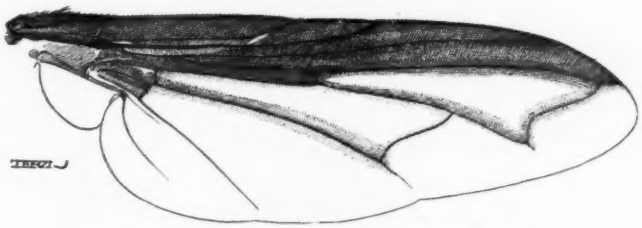

Fig. 4. *Exogaster hemimelaena*, n. sp., ♂, wing × 12.

and sternopleura there is also a broad stripe of white dust. Scutellum black, with a dark reddish hind border. All the bristles are black; *dc.* thin and short; scutellum with basal, preapical and apical bristles, these latter being only half as long as the preceding ones. Calypters white; halteres with yellowish stalk and blackish knob. *Abdomen* distinctly clavate; it is rather shining, with black hairs and bristles, and with faint white dust at the base of the segments. The first segment is black on the basal half and red on the apical half, but on the sides the red is extended below about to the base; the basal black band is extended to the hind border of the segment along the middle line, thus forming a longitudinal stripe, which becomes gradually attenuated behind; moreover the hind border of the segment is narrowly black in the middle. Second segment red on the fore half and black on the hind half, but on the sides the black extends below to the base; on the dorsum the black is prolonged forwards in the shape of a middle longitudinal stripe, which is attenuated in front. Third and fourth segments entirely black, but the genitalia are red. First segment with one pair of bristles in middle of hind border; second segment with a median hind pair and one on the sides; third and fourth with a

complete row at hind border. The *legs* have red coxae and red femora, black tibiae and black tarsi, but the tibiae are dark reddish near the base; all the bristles and the hairs are black, as are the long claws; pulvilli also blackish. *Wings* greyish-hyaline, with the fore half infuscated to the third longitudinal vein; moreover the 4th and the 5th veins are margined with fuscous, even along the apical cross-vein; the first basal cell is infuscated to the end; the appendix of the cubital angle is short but strong.

Loc. Seychelles: Praslin, one ♂, 1905 (Gardiner).

Tachininae.

43. *Discochaeta liliputiana*, n. sp.

A small, shining black species of almost globular shape with bare eyes, first posterior cell of the wings closed and no discoidal bristles on abdomen.

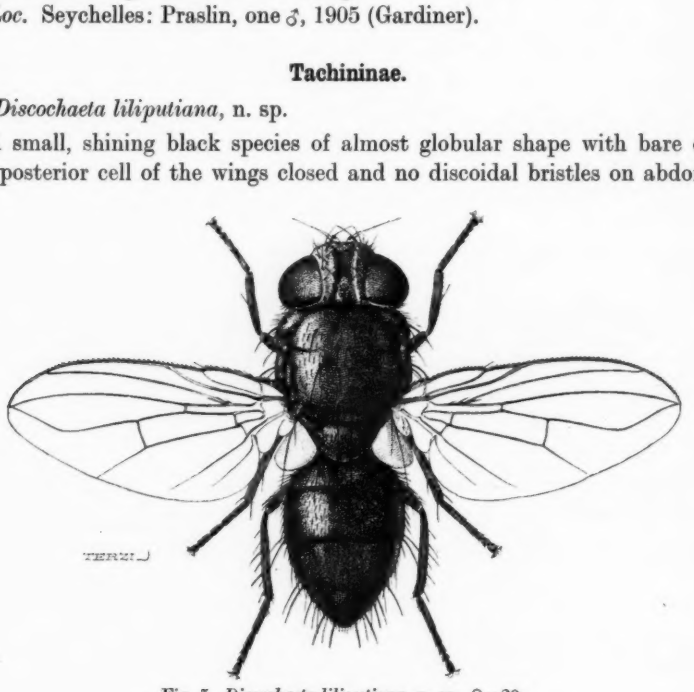

Fig. 5. *Discochaeta liliputiana*, n. sp., ♀ × 20.

It is provisionally placed in the present genus on account of the decussate apical scutellar bristles, but differs in the want of discoidal macrochaetae.

Myxactia, Villeneuve, is described as having hairy eyes and thin bristles as in *Arrhinomyia*. The description of the genus *Pentamyia*, B.B., also indicates many points of agreement with the present species (except in the presence of discoidal abdominal bristles), but the type-species of that genus has been recognized by Dr Villeneuve to be no other than *Arrhinomyia tragica*, M. This latter closely resembles *Discochaeta liliputiana*, but has discoidal bristles and divergent apical scutellar bristles.

♀. Length of body 2·5 mm.; of wing 2 mm. *Head* black, with whitish dust along the eye-margins and with the frontal middle stripe reddish. Antennae with the second joint reddish in part; third joint three times as long as the second;

arista incrassated beyond the middle, with small basal joints. Palpi reddish. *Oc.* long and strong, as are the other cephalic bristles; 5–6 strong vibrissae, ascending to the root of the arista. Eyes quite bare. Peristomialia moderately broad. *Thorax:* mesonotum shining black, with a faint grey dust on the back, without distinct pattern; 2 + 3 well developed *acr.* and *dc.* Scutellum shining black, with two pairs of long lateral bristles and the apical ones decussated at the end; there is one pair of short discoidal bristles. Calypters whitish-yellow; halteres blackish. *Abdomen* entirely shining black, with a faint dark grey dust, but without any pattern; macrochaetae long and strong, but no discoidal ones; first segment with one median pair at hind border; second segment with one median and one lateral pair; third and fourth segments each with a complete row of about 10. *Legs* rather short and stout, with reddish-brown femora; front tarsi not dilated; claws and pulvilli very short. *Wings* greyish-hyaline, iridescent, with a faint yellowish tint on the basal half; no costal bristle; veins yellowish, the third with 2–3 long bristles at base. Small cross-vein placed before the end of the first longitudinal vein; hind cross-vein straight and short, considerably nearer to the small cross-vein than to the cubitus; first posterior cell rather narrow, ending near the tip of the wing, closed at border (not stalked as in *tragica*), or very shortly stalked.

Loc. Seychelles, Mahé: Cascade Estate, about 800 ft., 1908–9, one ♀.

44. *Actia spoliata*, n. sp.

A smallish species very near *exoleta*, Meig., and *tibialis*, R.-D., but without any white tomentum on the abdomen, except the very narrow white basal bands of the segments.

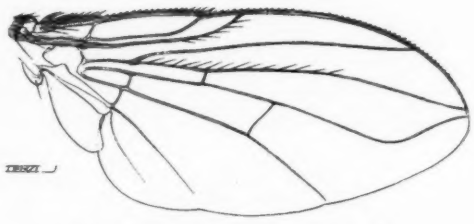

Fig. 6. *Actia spoliata*, n. sp., wing × 16.

♂♀. Length of body 3·5–4 mm.; of wing 3–3·5 mm. *Head*, its appendages and chaetotaxy as in *exoleta*, but the arista with the basal joints shorter; the third antennal joint in the female is blackish, narrow and shorter than the face, while in the male it is reddish, very broad and distinctly longer than the face. *Thorax:* back of mesonotum shining black, with a distinct whitish pattern consisting of a broad notopleural patch, a narrow but complete transverse band along the suture and a broad subquadrate patch before the scutellum. Scutellum shining black, narrowly grey dusted on the sides, with the hind border very narrowly reddish, but the red colour is not visible from above.

Abdomen entirely shining black, with three narrow complete white bands at the extreme base of the 2nd, 3rd and 4th segments respectively; these bands are extended on the sides and below on the venter, and are narrowly interrupted above in the middle, chiefly in the female, whose abdomen is broader, flat and obtuse at end. Chaetotaxy as in *tibialis*. *Legs* entirely black, even on the tibiae; claws and pulvilli very small in both sexes. *Wings* as in *tibialis*, and with the same ciliation of the first and of the third longitudinal veins.

Loc. Seychelles. Mahé, Silhouette, and Marie Anne Islands. Mahé: type ♂ from Cascade Estate, about 1000 feet, and a second ♂ from cultivated country at about 1000 feet. Silhouette: one ♂ from Mare aux Cochons plateau, over 1000 feet, ix. 1908. Marie Anne: type ♀, xii. 1908.

45. *Actia chrysocera*, n. sp.

A pretty species, closely allied to *silacea*, Meig., but distinguished by the different arista, the black abdominal pattern and black tibiae. The pubescent arista with small basal joints is as in my *Actia heterochaeta* (1908) from Erythraea; but the ciliation of 1st, 3rd and 5th longitudinal veins is as in the allied West African species *cibdela*, Villeneuve, and *languidula*, Villeneuve (both 1913).

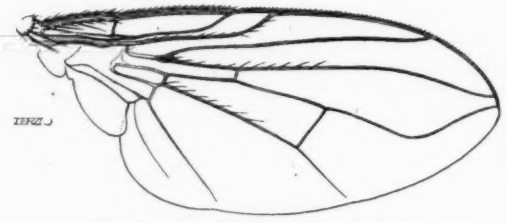

Fig. 7. *Actia chrysocera*, n. sp., wing × 16.

♂. Length of body 5 mm.; of wing 4 mm. *Head* dullish yellow, covered with a dense golden tomentum on the sides, blackish on the upper part of the occiput; frontal stripe dark yellow, but the ocellar triangle is dusted like the parafrontalia. Antennae entirely golden-yellow, with the third joint rather broad, rounded at the end, a little shorter than the face, 5–6 times longer than the second; arista yellowish, with short basal joints, and distinctly pubescent. Palpi and proboscis yellow. All the bristles black; two pairs of strong exterior *or.* bent forwards. *Thorax:* the ground-colour of the mesonotum is dark yellow, but it is densely clothed with grey dust, the back appearing thus darker and without pattern; *dc.* less developed, those in front of the suture being not differentiated. Scutellum like the back of the mesonotum; calypters and halteres yellowish. *Abdomen* rather shining, yellow, with a black pattern; the base of the 2nd, 3rd and 4th segments has in each case a narrow transverse band of whitish pollen; 2nd segment with a triangular black spot on the middle, its apex not reaching the fore border; 3rd segment shining black,

narrowly yellowish in front; 4th segment entirely shining black. First segment without bristles; 2nd segment with pair of strong erect bristles in the middle of the hind border; 3rd and 4th each with a complete row of 7–10. Hypopygium reddish-yellow, with two pale yellow appendages below. *Legs* with yellow coxae, trochanters and femora, and with black tibiae and tarsi. Claws and pulvilli very short and small. *Wings* whitish, with pale yellowish veins; no costal bristle; first posterior cell open; hind cross-vein nearer to the small cross-vein than to the cubitus. First longitudinal vein ciliated on its whole length; third ciliated to the middle of its length; fifth ciliated to the hind cross-vein; on the underside of the wings all these veins are bare.

Loc. Seychelles: type ♂ and a series of other specimens from Long Island, vii. 1908, frequenting shady places.

46. *Faunia fallax* (Meigen, 1824).

A species easily distinguished by its last abdominal segment being broadly red. This insect is found in Europe, and is widely distributed over Africa, being recorded from the Sudan and from the Congo by Dr Villeneuve in 1913; I have it from this last locality in my own collection.

Loc. Aldabra: one ♂, 1908–9 (Fryer).

This species is usually recorded under the generic name *Tachina* (*Larvae-vora*); but as this name must be more properly used for *Echinomyia*, Brauer and Bergenstamm in 1893 proposed the new name *Eutachina*, overlooking the fact that as long ago as in 1830 Robineau-Desvoidy (*Myod.*, p. 279, line 4 from the bottom) had suggested the name *Faunia* (reported in Scudder's "Nomenclator," from Agassiz) for the same purpose.

47. *Erycia* (*Bactromyia*) *? aurulenta* (Meigen, 1824).

A poorly preserved male specimen, which seems to belong to this European species.

Loc. Aldabra, 1908–9 (Fryer).

Gynandromyia, nov. gen.

I have to erect this new genus for a male specimen belonging to the group *Masicera* of Brauer and Bergenstamm, but presenting a peculiar assemblage of characters. It might be regarded as a hermaphrodite specimen, but on external examination it shows well developed male genitalia; it has outer *or.* like those of a female but long claws as in a male.

This new genus is allied to *Lydella* (*Dexodes*), but differs in having hairy eyes and exterior orbital bristles in the male. From *Thelymyia* it is distinguished by the long claws of the male; from *Conogaster* it differs in the long and decussate apical bristles of the scutellum. It is also distinct from the recently erected African genera, *Chaetolydella* and *Lydellina*, Villeneuve, 1916: from the former by the non-appendiculate cubitus, and from the latter by the non-ascending facial bristles.

Head: frons broad for a male, measuring about $\frac{1}{5}$ of the breadth of the

head; it is rather prominent in profile. *Antennae* inserted near the middle of the eyes, with the third joint about three times as long as the second, but not reaching the mouth-border. Arista long, bare, thickened only near the base, with the basal joints not distinct. Eyes hairy, rather narrow in profile, semicircular in front view, with small areolets all of equal size. Parafacialia bare, prominent in profile, but not broader than the breadth of the third antennal joint. Peristomialia narrow, about as broad as the parafacialia; lower border of head short and horizontal. Mouth-border not prominent; vibrissal angles not restricted, only a little convergent, with the longer vibrissa placed very near the mouth-border. Face concave, destitute of middle carina. Proboscis short, with fleshy labella; palpi as long as the proboscis, not much club-shaped. *Chaetotaxy of head:* inner *vt.* strong, long and decussate; outer *vt.* only half as long as the inner ones and very thin, almost hair-like. *Oc.* well developed, but shorter and thinner than the upper *or.* Interior *or.* about 12 pairs, extending anteriorly only to the end of the second antennal joint, the first pair only bent outwardly, the others being erect or bent inwards; two pairs of very strong exterior *or.*, both curved forwards; the parafrontalia bear moreover some short bristly hairs near the eyes. Facial ridges not ciliated, with only 4–5 short hairs above the longer vibrissa. Peristomial border with 6–7 long bristles; peristomialia setulose posteriorly. Postocular cilia rather short, placed in one row only, extending from the vertex to below the middle of the eyes. *Chaetotaxy of thorax: acr.* 3 + 3; *dc.* 3 + 4; *st.* 0.1.1. *Chaetotaxy of scutellum:* three pairs of latero-marginal bristles, the intermediate being smaller; one pair of discoidal; one pair of apical, long, strong, decussate but not erect, oblique as are the posterior lateral ones and only a little shorter. *Abdomen:* all the four segments of about the same length. They bear only marginal bristles, but these are well developed on the middle and on the sides, even on the two basal segments. *Genitalia* (♂)*:* fourth abdominal sternite a truncated plate. Forceps prong curved. *Legs:* hind tibiae not fimbriate. Claws and pulvilli of all the pairs much developed and elongate, as long as the last tarsal joint. *Wings:* no costal bristle. Basal stem of radius bare. First longitudinal vein bare; third vein with 2–3 long cilia at its extreme base. First posterior cell open, ending at a considerable distance before the tip of the wing. Cubitus obtuse, nearly rounded, not appendiculate; apical cross-vein a little curved inward beyond the cubitus, but straight in its remaining part. Hind cross-vein long, less curved, as oblique as the apical cross-vein, and nearer to the cubitus than to the small cross-vein. Sixth longitudinal vein not reaching the hind border. Small cross-vein placed before the end of the first longitudinal vein. Axillary lobe broad. *Calypters.* Lower squama very long and broad, quite bare above.

Genotype: the following new species.

48. *Gynandromyia seychellensis*, n. sp.

An entirely black, grey-tomentose species, with last abdominal segment shining black.

♂. Length of body 9 mm.; of wing 8 mm.

Head black. Occiput entirely grey dusted, with a white shine along the eye-margins, clothed with dense and long white hairs, only the postocular cilia being black. Frons with parallel sides; frontal stripe only a little broader than one of the parafrontalia, of a deep black colour; ocellar plate grey; parafrontalia with a white shine like that of the parafacialia, the latter with a reddish-brown spot below the eye; face whitish. Antennae and arista entirely black. Palpi dark yellowish, but clothed with dense black hairs; proboscis blackish, with yellowish and pale hairy terminal flaps. All the cephalic bristles black. *Thorax:* mesonotum black and rather shining, but densely grey dusted;

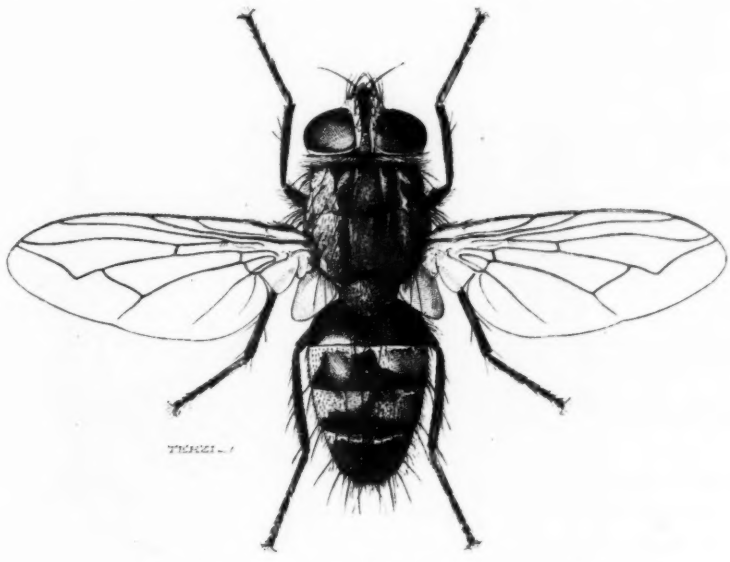

Fig. 8. *Gynandromyia seychellensis*, n. g. et n. sp., ♂ ×6.

on the back there are four complete, black, longitudinal stripes, the inner narrower than the outer, which are interrupted at the suture. Pleurae densely grey dusted, with a white shine on the mesopleura. Scutellum like the back of the mesonotum, but not striped; postscutellum and mesophragma black, grey dusted. All the bristles and hairs are black. Prothoracic stigma black. Calypters whitish, with narrow yellowish border; halteres blackish, with the stalk yellowish at base. *Abdomen* rather flat and obtuse at end; shining black, the 2nd and 3rd segments with broad grey tessellation, which is indistinct on the first segment; 4th segment entirely shining, with distinct dark bluish reflections, and with a very narrow complete ring of grey dust at the base; the 2nd and 3rd segments are white-shining on their ventral portion, with a narrow black hind border. First segment with two bristles on the middle at the

hind border, and one on each side; second with four on middle and one on each side; third with a complete row; fourth with two complete rows. Fourth sternite prolonged into an obtuse, shining black plate, which is convex and greyish above; forceps shining black. *Legs* entirely black and black-pilose; front femora with dense white dust below; claws black, pulvilli yellowish; middle tibiae with a single but very long bristle near the middle of the anterior side; hind tibiae with three long bristles near the middle, but only one on each side. *Wings* greyish-hyaline, indistinctly yellowish towards the base; veins dark yellowish, but the costa appears black on account of its dense black ciliation, which is rather long on the basal part, before the humeral cross-vein.

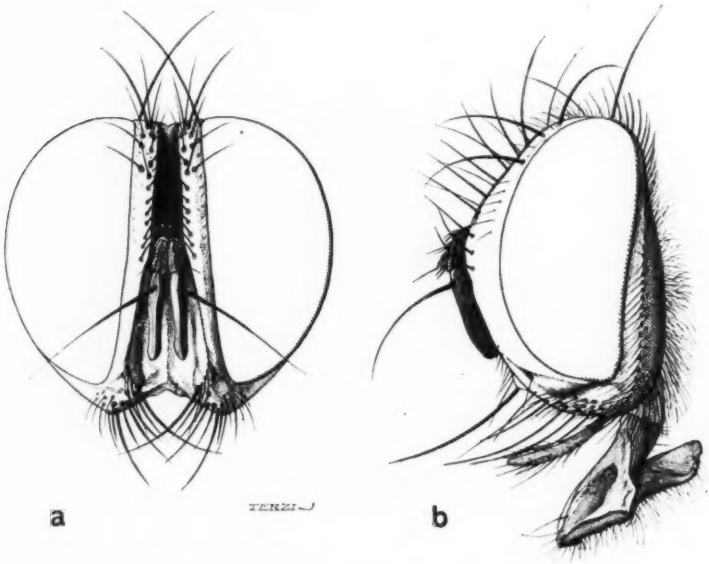

Fig. 9. *Gynandromyia seychellensis*, ♂; head, *a*, front view, *b*, profile; both ×ca. 17.

? *Female:* much smaller, measuring only 6 mm. in length; it shows all the characters of structure and chaetotaxy of the above described male, but I am in doubt about its true position, because it has the antennal arista distinctly, even if very shortly, pubescent; while in the male this organ is quite bare.

Head: the frons in breadth, shape and ciliation is exactly as in the male. The eyes have shorter hairs, as is usually the case in the female. *Thorax:* the back of the mesonotum has the black longitudinal stripes broader; on the scutellum the middle pair of lateral bristles is wanting. Halteres quite yellowish. *Abdomen* acute behind; fourth segment with the basal half clothed with whitish dust; the second segment has only two median bristles at the

hind border. *Legs* with very short claws and pulvilli; front tarsi not dilated. *Wings* as in the male, but with the apical and hind cross-veins shorter and less oblique; cubitus less obtuse and less rounded.

Loc. Seychelles. Mahé: Cascade Estate, about 1000 ft., 1908–9, one ♂ (type); the ♀ is from the same locality.

49. *Exorista nemorilloides*, n. sp.

A small species showing the abdominal pattern of a *Nemorilla*, but with no discoidal bristles on the abdomen, and with the third joint of the antennae twice as long as the second[1].

♂♀. Length of body 5–6 mm.; of wing 4·5–5·5 mm. *Head* black, with white-shining sides and face. Frons of the male $\frac{1}{5}$, of the female $\frac{1}{3}$, of the breadth of the head; frontal stripe deep black, in the male much broader than the parafrontalia, in the female only a little broader than these. Eyes clothed with long and dense grey hairs. Parafacialia narrow and linear, bare; peristomialia about as broad as the breadth of the third antennal joint. Antennae black, as long as the face; third joint twice as long as the second; arista long, not thickened to the middle, with short basal joints. Palpi black. Parafrontalia pilose, in the female with one strong exterior *or.*; interior *or.* descending in one row to the root of the arista. *Oc.* well developed; facial ridges with only 3–4 short hairs above the long vibrissa. *Thorax:* mesonotum of the male deep black, with two distant, complete, white longitudinal stripes, one on each side along the *dc.* lines; there is a broader notopleural band, extending from the humerus to the root of the wing. In the female the back of the mesonotum is more greyish, with four longitudinal black stripes. *Dc.* 2 + 4; *acr.* 2 + 3; *st.* 1 + 1. Scutellum entirely black, dullish in the male and shining in the female, with three pairs of lateral bristles, one pair of discoidal, and one pair of thin but long and decussate apical, which are not erected. Calypters white; halteres blackish, with yellowish stalk. *Abdomen* flat and broad, black; first segment entirely black; second and third segments with four white-shining spots on the front half as in *Nemorilla*; fourth segment with the same, but the pattern is less marked. In the female all the segments are almost entirely greyish, with blackish tessellation. First segment with two marginal bristles in the middle, slender and sometimes wanting; second segment with two strong bristles; third and fourth each with a complete row. *Legs* quite black; hind tibiae with scattered ciliation and longer bristles on the inner side; claws and pulvilli of male long, of female very short; front tarsi of female not dilated. *Wings* greyish-hyaline, with no costal bristle; third longitudinal vein with only one bristle at base; first posterior cell very narrowly open, and sometimes even closed at the wing-border. Cubitus at a right or obtuse angle; apical cross-vein outwardly concave.

Loc. Seychelles. Silhouette: near coast, ix. 1908, type ♂ and one other ♂, type ♀ and four additional ♀.

[1] Dr Villeneuve has shown (*Wien. Ent. Zeit.*, xxxvi, 1907, p. 251) that the genus *Alsomyia* B.B., must be suppressed, as its type-species was merely a species of *Exorista*.

50. *Sturmia* (*Argyrophylax*) *inconspicua* (Meigen).

Tachina inconspicua, Meigen, 1830.
Tachina imberbis, Wiedemann, 1830.
Tachina bimaculata, Hartig, 1838.
Argyrophylax idonea, Brauer und Bergenstamm, *Denkschr. Ak. Wien, Math.-Nat. Kl.*, LVIII, 1891, p. 344.
Sturmia inconspicua (Meigen) Villeneuve, *Rev. Zool. Africaine*, III, p. 434, 1914.

This species occurs in Europe and is widely spread over the Ethiopian Region.

Loc. Providence (Farquhar Group): Cerf I., 13. x. 1905, two male specimens and a puparium, bearing the label "this Tachinid was bred from larva of *Plusia chalcytes* [Noctuidae], T. Bainbrigge Fletcher." [In the *Kat. Paläarkt. Dipt.*, vol. III, Budapest, 1907, p. 226, the following insects are given as hosts of *Sturmia bimaculata* (treated above as a synonym of *inconspicua*); the moth *Lymantria monacha*, L., and several species of sawflies of the genus *Lophyrus*.]

ON A NEW SCHIZOGREGARINE: *SCHIZOCYSTIS LEGERI* N.SP., AN INTESTINAL PARASITE OF DIPTEROUS LARVAE (*SYSTENUS*).

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(*From the Molteno Institute for Research in Parasitology, Cambridge.*)

(With Plate IV.)

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Material and Methods.

The hosts of the new Schizogregarine herein described are the larvae of Dolichopodid flies: *Systenus adpropinquans* Loew and *S. scholtzii* Loew which live in the decomposed sap or wood-pulp filling the wounds of Elm and Horse-chestnut trees. The larvae used for the present study have been obtained from two trees only: an Elm tree standing on the Caius College playing ground at Newnham and a Horse-chestnut tree standing on the Downing site. The new parasite *Schizocystis legeri* n.sp., in company with a gregarine *Dendrorhynchus systeni* Keilin (1920), often completely fills the lumen of the host's midgut, but, even when heavily parasitised, the host does not show any sign of infection. The latter can only be detected when the larvae, slightly pressed between a slide and a coverslip, are examined under the microscope.

The parasite has been studied on smears fixed in Schaudin's solution and the sections of the whole body of the host fixed in Carnoy. Both smears and sections have been stained in glychaemalum or in iron haematoxylin and eosin.

Schizonts and Schizogony.

I have not yet seen the sporozoite of this parasite; the youngest forms found in smears or sections, which are apparently not derived from the schizogonic multiplication, are the small vermiform organisms 10 μ long and 2 μ in diameter. *Sch. legeri*, like the species described by Léger, has two kinds of schizonts: vermiform and massive. The characteristic features of this

gregarine are specially well shown in a full grown vermiform schizont. At this stage (Pl. IV, fig. 5) the gregarine reaches 56μ in length and 10μ to 13μ across its widest portion. Its body is pointed posteriorly, while the anterior portion is differentiated into a small knob-like protomerite of about 5 to 6μ in diameter, separated from the deutomerite by means of a very thin septum. The ectoplasm shows a very faint longitudinal striation but is not differentiated into the three layers characteristic of gregarines. The endoplasm has a distinct vacuolar structure and shows small scattered basophile granules. The nuclei which, in a full grown schizont, are eight in number, are usually disposed along the longitudinal axis of the deutomerite (Pl. IV, fig. 3). Each nucleus is about 2 to 2·5μ in diameter with a large karyosome occupying almost the whole of its volume. The number of the nuclei in a schizont does not strictly correspond to the size of the parasite; in fact, there are large specimens showing two or three nuclei while other small specimens 23μ or 32μ long contain respectively four or eight nuclei (Figs. 1 and 2).

When the schizonts reach their full size they lose the vermiform appearance, the septa disappear, they become irregular in shape and form peripheral protrusions or lobes of various sizes containing one or more nuclei. The body of the schizont finally divides into several portions having an unequal number of nuclei (Figs. 13, 15, 16, 17 and 18). The portions thus obtained divide in their turn until they give rise to a small spherical merozoite of 8μ in diameter with only one small nucleus (Fig. 9). The merozoite grows, differentiates a protomerite, its nucleus divides mitotically several times and the merozoite is gradually transformed into a typical octonuclear schizont. In a few specimens I have noticed a kind of terminal budding of the schizont, the posterior portion of which, separated by a stricture from the rest of the body, is finally detached from it and transformed into a small spherical schizont with one to four nuclei surrounded by very basophile protoplasm (Fig. 14). It is quite possible that these spherical bodies give rise to the second kind of schizonts known as massive schizonts. The latter are very rare: among my specimens they occurred only in a few infested larvae and in very reduced numbers. They are usually in the form of spherical or slightly elongated bodies of various sizes from 8μ to 14μ in diameter with four to eight nuclei (Figs. 9, 11, 12). Only two schizonts (of about 27μ long and 14μ wide) among several hundreds of parasites, have been found with twenty to twenty-two nuclei (Fig. 10). The protoplasm of these schizonts, especially when they are of the small type, is very basophile. I have not yet seen these schizonts undergoing division, but I presume it takes place in similar manner as in the vermiform schizont previously described.

Among the parasitised larvae two specimens have been found with various stages of *Schizocystis* free in the perivisceral or body cavity of the host. The abnormal position of the gregarines was undoubtedly due to an accidental perforation or rupture of the host's midgut, the contents of which had been emptied into the body cavity during life. In fact, in both cases, in addition to

the Schizogregarine, the perivisceral fluid of the larvae was heavily infected with various intestinal bacteria. Moreover, the structure of the Schizogregarine was not normal: the karyosome of the nuclei were less chromatic while the protoplasm was charged with an enormous number of basophile granules (Pl. IV, fig. 4).

GAMETOCYTES AND SPOROGONY.

The sporogonic cycle of this gregarine has been found in a few larvae only. When it takes place it rapidly replaces almost all the schizogonic forms and the whole lumen of the alimentary canal, especially near the hindgut, becomes filled with numerous cysts in various stages of development. The gametocyte when only 20μ long is already recognisable by the structure of its nucleus, which is distinctly vesicular, 3 to 4μ in diameter with a large karyosome and traces of peripheral chromatin. The full grown gametocytes, when of about 35μ long, form copulae. They then become hemispherical, secrete a thin transparent cyst, almost spherical in shape and 18μ to 21μ in diameter. Its nuclei undergo several mitotic divisions (Pl. IV, figs. 19, 20 and 21) and by a process common to all gregarines, small gametes are formed. The latter unite in pairs and form the spherical sporoblasts of 3, 5 to 4μ in diameter (fig. 22) which become elongated and transformed into typical sporocysts 7μ long and 3μ across their middle portion. The peripheral nucleus of the sporoblast undergoes two divisions and then forms four nuclei embedded in a basophile granular protoplasm which does not yet show signs of plasmotomy. It is almost certain, however, that the four nuclei ultimately divide once more and give rise to the nuclei of eight sporozoites. This last division may take place outside the host's body in the cysts expelled with the excrement.

THE GENUS *SCHIZOCYSTIS*.

The new species of Schizogregarine described herein under the name *Schizocystis legeri* n.sp. is dedicated to Professor L. Léger of Grenoble who has established the genus *Schizocystis* for the species *Sch. gregarinoïdes* discovered by him in the gut of Ceratopogonid larvae. Before we proceed to compare our species with that of Léger it is important to examine the characters and to discuss the systematic position of the two other species included in the genus *Schizocystis*, *Sch. sipunculi* and *Sch. spiniger*.

(1) *Schizocystis sipunculi* Dogiel.

This gregarine was discovered in the gut of *Sipunculus nudus* by Dogiel (1907) who described only its schizogonic multiplication. This seems to be of a very peculiar type, the merozoites being formed inside the body of a full grown trophozoite. The figures and descriptions of this author leave, however, some doubt as to the correctness of his observations. In fact, he has not seen the early stages of schizogonic development and the merozoites found by him inside the gregarines are probably developed outside the body of the parasite. It is quite possible that the real schizogony of his species takes place inside

the cells of the host's midgut and that the merozoites after having escaped from these cells have accidentally attached themselves to and invaded the full grown trophozoite. It seems to me at present impossible to determine the correct systematic position of this species; one can only say that it does not belong to the genus *Schizocystis* and that it has more resemblance to the forms belonging to the genus *Selenidium* as has been already shown by Fantham (1908) and Léger (1910).

(2) *Schizocystis spiniger* Machado.

This species of gregarine was discovered by Machado (1913) in the gut of an insect: *Spiniger* sp. (Fam. Reduviidae). Schizogonic multiplication seems to be very rare and if it exists in this species it differs markedly from what has been observed in *Schizocystis gregarinoïdes*, having all the mezoroites formed around a residual protoplasmic body and under the epicyte layer of the schizont. The other striking character of this species is the frequent occurrence of the polynuclear forms, which the author compares to the solitary encystment known in various gregarines. All this demonstrates that this species must be excluded from the genus *Schizocystis*.

Schizocystis gregarinoïdes Léger and *Sch. legeri* n.sp.

The genus *Schizocystis* contains thus only two species: (1) *Schizocystis gregarinoïdes* Léger and (2) *Sch. legeri* n.sp. described in this paper.

The following table shows the chief characters of these two species:

	Schizocystis gregarinoides	*Schizocystis legeri*
(1) Young schizont or the smallest multinuclear trophozoite	30 μ long at the first nuclear division	10 μ to 20 μ long with several nuclei
(2) Full grown schizont:		
(*a*) size	350 μ to 400 $\mu \times 15\,\mu$	56 $\mu \times 10$ or 13 μ
(*b*) number of nuclei	100 to 200	8
(3) Structure of vermiform schizont	No septum, no protomerite, anterior portion differentiated into a sucker-like structure	Body divided by a septum into protomerite: 5 to 6 μ in diameter and deutomerite
(4) Massive schizont:		
(*a*) size	35 μ long	27 $\mu \times 14\,\mu$
(*b*) number of nuclei	20	4 or 8, very rarely 20 to 21
(5) Merozoite when formed	20 μ to 25 μ long	8 μ to 10 μ long
(6) Gametocyte	40 μ long	35 μ long
(7) Cyst	20 $\mu \times 25\,\mu$	18 $\mu \times 21\,\mu$
(8) Sporocyst	8 $\mu \times 4\,\mu$	7 $\mu \times 3\,\mu$
(9) Host: larvae of	Diptera Nematocera Fam. Ceratopogonidae *Ceratopogon* sp. *Ceratopogon solstitialis* Larvae: aquatic, saprophagous	Diptera Brachycera Fam. Dolichopodidae *Systenus adpropinquans* *Systenus scholtzi* Larvae: from wounds of trees, carnivorous
(10) Locality	France: Lac Luitel in the Alps; mill race at Dauphiné; sea-shore pond at Cavalier (Var)	England: Cambridge

SUPPOSITION AS TO THE ORIGIN OF INTESTINAL PROTOZOA IN *SYSTENUS* LARVAE.

Schizocystis legeri is often found in company with an Eugregarine *Dendrorhynchus systeni* Keilin previously described (1920). This gregarine is the only form which shows resemblance to *Taeniocystis mira* Léger, in that it has numerous transverse fibrillae penetrating often deep into the endoplasm and there forming septa similar to those of *Taeniocystis*.

We find thus in the two different hosts: (1) Ceratopogonid larvae and (2) the larvae of *Systenus*, a similar association of two intestinal parasites. In the former *Schizocystis gregarinoïdes* with *Taeniocystis mira*; in the latter *Schizocystis legeri* with *Dendrorhynchus systeni*. This remarkable resemblance in the parasitic fauna of two hosts belonging to different sub-orders of Diptera (Nematocera and Brachycera) becomes all the more interesting when we take into consideration the marked difference in their feeding habits: Ceratopogonid larvae being saprophagous, while the larvae of *Systenus* are carnivorous.

On the other hand, the last consideration seems also to throw some light on this problem. The larvae of *Systenus* living in the decomposed sap or wood filling the wounds of trees are often found in company with numerous Ceratopogonid larvae which, among other larvae, constitute their main food supply.

It is quite possible that among these Ceratopogonid larvae one species at least may have contained intestinal parasites similar or identical to those described by Léger. These parasites being frequently taken up by *Systenus* with its food have gradually succeeded in adapting themselves to the new conditions of life in the alimentary canal of *Systenus*, undergoing at the same time more or less marked changes.

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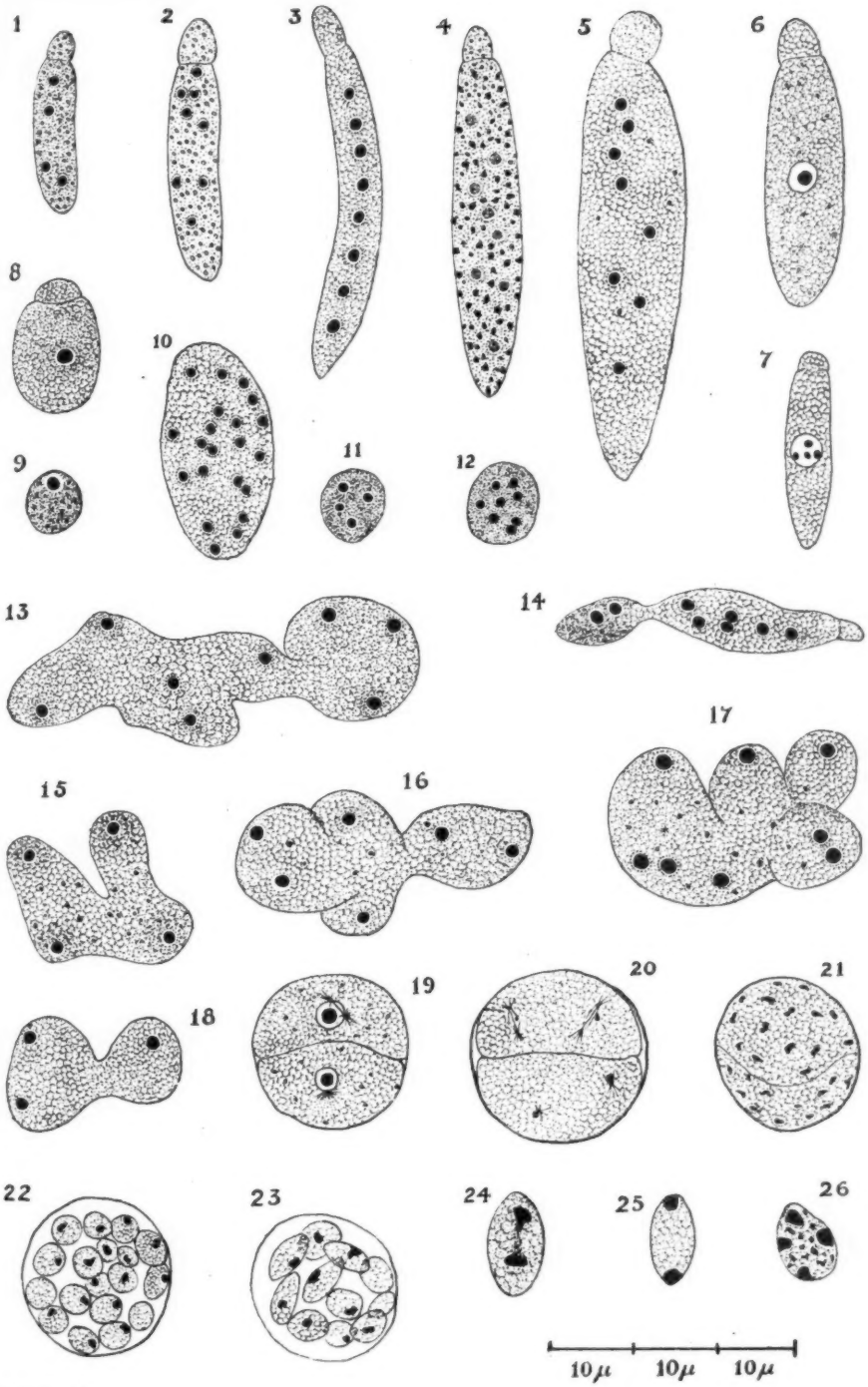
EXPLANATION OF PLATE IV.

Schizocystis legeri n.sp.

Magnification of Figs. 1 to 23 as in scale. Figs. 24, 25 and 26 ×2500.

Fig. 1. Small quatrinuclear vermiform schizont.
Fig. 2. Small octonuclear vermiform schizont.
Fig. 3. Usual type of a full grown schizont.
Fig. 4. A full grown schizont from perivisceral or body cavity of the host (from a case of accidental perforation of the infested gut of the host), showing faintly stained nuclei and numerous basophile corpuscles in the cytoplasma.
Fig. 5. Typical full grown vermiform schizont previous to schizogonic division.
Figs. 6 and 7. Full grown and young gametocytes.
Fig. 8. Intermediate form between massive and vermiform schizonts.
Fig. 9. Young merozoite.
Fig. 10. Exceptional multinuclear specimen (with 21 nuclei) of massive schizont.
Fig. 11. Typical quadrinuclear massive schizont.
Fig. 12. Typical octonuclear massive schizont.
Fig. 13. Schizogonic division or plasmotomy of schizont.
Fig. 14. Terminal budding of schizont.
Figs. 15, 16, 17 and 18. Specimens showing various stages of schizogonic divisions.
Figs. 19. Freshly formed cyst showing beginning of the first mitosis.
Figs. 20 and 21. Cysts showing divisions previous to formation of gametes.
Figs. 22 and 23. Cysts showing sporoblasts and young sporocysts.
Figs. 24, 25 and 26. Successive stages of formation of sporozoites in sporocysts.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D. Keilin del.

NOTES ON THE LIVES OF GIARD, BONNIER AND DELAGE, WHOSE PORTRAITS APPEAR IN *PARASITOLOGY*, XV, No. 1.

Portrait-plates XXI—XXIII.

(Continued from Vol. XIV.)

By D. KEILIN, Sc.D.

(*From the Molteno Institute for Research in Parasitology.*)

Alfred Giard.

1843–1908.

(Portrait-plate XXI.)

Alfred Giard was born at Valenciennes (Nord) on the 8th of August, 1843, and died at Orsay (Seine-et-Oise) on the 8th of August, 1908. He received his education at the "Ecole Normale Supérieure" of Paris and in 1873, having obtained his D.Sc. at the Sorbonne, he was elected to the chair of Natural History at the University of Lille. In 1874 he founded at Wimereux, near Boulogne, a marine zoological station and in 1878 became editor of the *Bulletin Scientifique de la France et Belgique*, which still appears and counts now fifty-five volumes. In 1882 he was elected member of Parliament but, fortunately for his scientific career, lost his seat at the next election in 1885. Three years later the Town Council of Paris endowed for him at the Sorbonne a lectureship of Evolution which soon developed into a Professorial chair of "Évolution des Êtres organisés." In 1900 he was elected a member of the Institute.

Giard was the author of more than 600 scientific papers covering the wide field of General Biology and Zoology. One can hardly mention a group of animals from Protozoa to Man or a branch of Biology which has not been touched, and usually in a masterly way, in the numerous papers he has published. In fact, a mere glance at the list of his publications reveals the great variety of subjects he studied. We find there problems of evolution, embryology, cytology (pure and applied), terrestrial and marine zoology, distribution of animals and plants, comparative psychology, parasitology, bacteriology, mycology, hygiene. His contributions to Parasitology are very numerous and deal with the representatives of practically every order of Parasites, namely: Bacteria, Fungi, Protozoa, Worms, Crustacea and Insects.

It is impossible in this short notice to give more than a faint idea of the scope and importance of this work. Of the problems he investigated we can mention here only a few which will always remain associated with his name. In 1877 he discovered the Orthonectidae which forms a new group of parasitic organisms composed of a limited number of cells and the systematic position of which still remains unknown. In 1886 he discovered a most interesting case of a Turbellarian (*Fecampia*) parasitic in Crabs. His investigation on parasitic Crustacea—Copepoda, Rhizocephala and Epicaridae—occupied him almost throughout his life. In the course of this study by himself or in collaboration with J. Bonnier he discovered many new forms and new life-cycles of these interesting parasites and elucidated a series of problems of general Parasitology, concerning chiefly the inter-relationship between the host and the parasite. This study led him to the discovery of "Parasitic castration" in animals and plants, a term which he introduced to designate the changes in the secondary sexual characters of the host caused by the parasite, even when the latter does not directly attack the host's gonads.

Giard had the most stimulating influence on his numerous pupils (at Lille, Wimereux and Paris) as well as on his scientific correspondents, who often being far from centres of civilisation found in Giard not only an inexhaustible source of information but a true guide in their various investigations.

This explains his success in creating a real school of research which had a great influence on the direction of biological investigation in France, where at one time and even now a great number of chairs of Zoology or Biology have been and are occupied by his pupils.

The following sources of information have been consulted for the purpose of this notice: (1) Alfred Giard, 1896, *Exposé des titres et travaux scientifiques* (1869–1896). Paris: Imprimerie générale, Lahure. (2) Obituary Notices, by F. Le Dantec and M. Caullery, in *Bull. Sc. de la France et Belgique*, 1909, vol. XLII, pp. iii–lxxiv. (3) Alfred Giard, *Œuvres diverses réunies et rééditées par les soins d'un groupe d'élèves et d'amis* (1911). 2 vols. Paris: Laboratoire d'Évolution des Êtres organisés.

Jules Bonnier.

1859–1908.

(Portrait-plate XXII.)

JULES BONNIER was born at Templeuve (Nord) on the 31st of August, 1859, and died at Paris the 10th of May, 1908. He received his education at the University of Lille where he met A. Giard, then Professor of Natural History. He followed Giard to Paris and became Assistant Director of the Laboratory of Evolution and of the marine zoological station of Wimereux. Throughout his life he was one of the most devoted pupils and friends of Giard and for many years collaborated actively with him in a series of important investigations on parasitic Crustacea. In addition to many papers, published by himself

or with Giard, J. Bonnier published in 1900 a magnificent Monograph on Epicaridae ("Contribution à l'étude des Epicarides: Les Bopyridae"), which he submitted as his dissertation for the degree of D.Sc. at the Sorbonne.

This monographic study of about 400 quarto pages and 41 beautifully drawn plates contains the results of many years' work. It deals with the great variety of parasitic adaptation found in this group and with most interesting cases of inter-relationship between the parasite and the host. Bonnier took part in several scientific expeditions. In 1904 while taking part in a Polar expedition with de Gerlach and Ch. Pérez he suffered a mental breakdown and was brought back to France by his friends, in a state from which he never recovered.

The portrait is reproduced from a picture presented by his brother, L. Bonnier, in June 1920. For biography and list of his publications (1884–1903), see Obituary notices, in *Bull. Sc. de la France et Belgique*, 1909, vol. XLII, pp. lxxv–lxxxiv.

Yves Delage.

1854–1920.

(Portrait-plate XXIII.)

YVES DELAGE was born on the 13th of May, 1854, at Avignon and died on the 7th of October, 1920, at Paris. At the age of 19 he went to Paris to study medicine and science. The teaching of M. de Lacaz-Duthiers, then Professor of Zoology at the Sorbonne, captivated his mind and decided him to take up Zoology as his speciality. In 1878 he received the diploma of "Licencié ès Sciences Naturelles," and obtained the post of demonstrator at the marine zoological station of Roscoff. In 1880 he obtained the degree of M.D. and a year later that of D.Sc. (Sorbonne). In 1882 he became Lecturer of Zoology at the Sorbonne and two years later went as Professor of Zoology to Caen and as Director of the marine zoological station at Luc, but in 1886 returned to Paris to take the chair of Zoology and Directorship of Roscoff station left vacant by the death of de Lacaz-Duthiers. In 1901 he was elected member of the Institute, in 1906 obtained the degree of LL.D. from Aberdeen University and in 1916 was awarded the Darwin Medal of the Royal Society, London.

Delage worked on a great variety of problems embracing the fields of Zoology and general Biology. The first years of his research were mainly given to the problems of pure Zoology, Embryology, and Physiology. To this period belong his important studies of *Sacculina*, development of sponges and physiology of the semicircular canals in man. In 1895 he published his remarkable book on *Heredity and the great problems of General Biology*, and soon after founded the well-known journal *L'Année Biologique*, which he edited until his death. The year 1895 marked a radical change in the direction of his research, all his attention then being drawn towards the problems of general Biology. To this period belong his remarkable investigations on

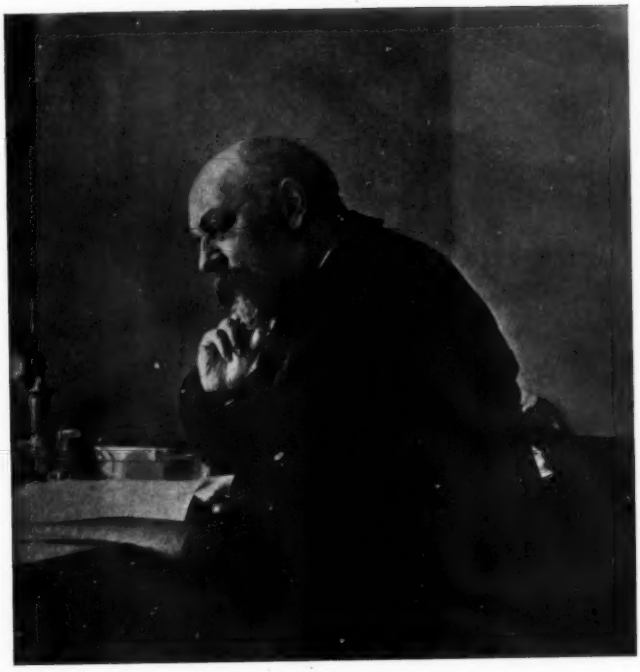
merogony and artificial parthenogenesis, which he carried on until 1912 when, having completely lost the use of both his eyes, he had to give up all laboratory work. This terrible blow did not however diminish his activity, for being always interested in various general problems he directed his attention to those of comparative psychology, which mainly required great mental effort and imagination. During this time he also invented various oceanographic instruments.

Delage's contributions to Parasitology are not numerous but we owe to him the important study on *Sacculina* (Rhizocephala) which can be placed among the classical examples of parasitological investigations. In addition to discoveries of numerous new points in the structure of this parasite, Delage succeeded in discovering its complete life history. He found that an undifferentiated mass of cells from the body of *Cypris* passes down the antenna of the latter into the body cavity of the crab and there develops into the previously unsuspected internal stages of this parasite.

Delage transformed the marine station of Roscoff into a real centre of research on marine biology and it soon became a place of summer gathering for zoologists from all over the world.

Our portrait is reproduced from a photograph presented by Madame Delage.

For biography see Obituary notices, by M. Goldsmith, in *Revue Générale des Sciences*, 1920, vol. xxx, pp. 708–11, and in *Année Biologique*, 1920–1921, nouv. série, T. 1, pp. v–xix; by J. Arthur Thomson, in *Nature*, 1920, vol. 106, p. 248.



ALFRED GIARD

1843—1908

Separate copies may be obtained from the University Press, Cambridge

JULES BONNIER

1859—1908

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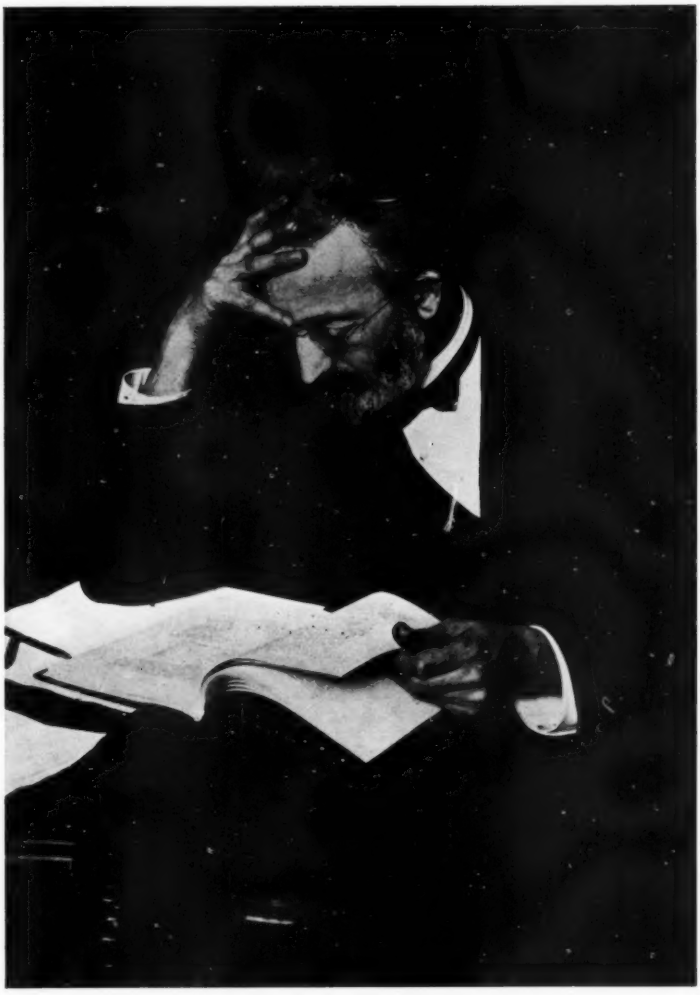

YVES DELAGE

1854—1920

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